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ITS METHODS AND PRINCIPLES

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PSYCHOLOGY
ITS METHODS AND PRINCIPLES

BY
FLEMING ALLEN CLAY PERRIN
PROFESSOR OF PSYCHOLOGY
THE UNIVERSITY OF TEXAS

REVISED EDITION OF
PERRIN AND KLEIN'S
PSYCHOLOGY

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To

R. B. P. AND R. B. K.

PREFACE TO THE REVISED EDITION

Although this text is essentially a revision of *Psychology: Its Methods and Principles,* it differs from the first edition in two important respects. In the first place, it assumes that introductory psychology should be presented from the eclectic point of view. The writer is convinced that both cultural and scientific considerations justify this standpoint in contemporary psychological thinking. In the second place, the present edition places special emphasis upon the integrative process. It follows the original edition in holding that behavior is fundamentally purposive or adaptive in character, but it supplements this view with the additional proposal that integration and adaptation are interdependent concepts.

Like the original edition, the present text is divided into a few relatively independent chapters. In particular, Chapter I is intended to be an essay on modern psychology. Instead of devoting a separate chapter to physiological and neuroanatomical considerations, the writer has endeavored to incorporate them into the body of the text in the various places where they are appropriate. Although the policy of making each chapter an independent unit has involved a certain amount of repetition of content, it is hoped that this organization will clarify the presentation as a whole.

In addition to the acknowledgments made in the first edition, the writer wishes to express his obligations to two of his colleagues at the University of Texas, Professors Harold Stevenson and L. A. Jeffress, for their constructive comments on Chapters I and III respectively.

F. A. C. P.

AUSTIN, TEXAS
June, 1932.

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PREFACE

In the present text psychology is presented as the science of adaptive behavior. The writers are convinced that the study of such behavior provides a more effective introduction to psychological science than the study of consciousness as such. However, they are not committed to the tenets of any particular psychological "school." They have utilized both behavioristic and introspective material, without attempting to distinguish between "introspection" and "verbal report." In fact, they are in entire accord with Hollingworth's position that the verification of psychological and other scientific phenomena finally is reduced to a question of statistical consistency. The writers use the term "stimulus-response" to designate the *program* of psychological investigation, but they employ this term in a strictly methodological sense. Throughout the text stress is placed upon the scientific methods by means of which adaptive behavior is investigated in the psychological laboratory.

In the writers' experience it has been found that the organization of the average text into chapters dealing with delimited topics—such as sensation, perception, intelligence, and imagination—induces the student to think of psychology in terms of "faculties." To minimize such suggestion of a faculty psychology they have articulated these topics with the larger problems of adjustment. The attainment of this objective necessitated a division of the text into relatively few but lengthy chapters containing numerous major and minor captions.

The writers are indebted to the following psychologists and publishers whose diagrams are reproduced in the text: W. F. Book, H. E. Jones, D. Starch, J. B. Watson, R. M. Yerkes, The Gregg Publishing Company and The Macmillan Company.

They are also indebted to the editors of the *American Review* for the privilege of interpolating part of an article by one of the writers in Chapter II. They acknowledge their obligations to Professor Joseph Peterson, who read and criticized the original draft of Chapter V, and to Professor E. T. Mitchell and Mr. William Carr, who rendered generous service in reading the proof. They are particularly grateful to Professor Roger Thomas for his efforts in connection with the preparation of the entire manuscript.

F. A. C. P.
D. B. K.

The University of Texas
August, 1926.

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PSYCHOLOGY

ITS METHODS AND PRINCIPLES

CHAPTER I

THE PSYCHOLOGIST'S VIEW OF MAN AND OF ANIMALS

Every one knows that psychology is concerned in some fashion with the mental life and with the behavior of man and of animals. In so far as this science deals with human beings, it may be considered as the science of human nature; but since it is interested also in animals, it includes the study of animal nature. Of course the human being is an animal, a creature of flesh and blood; or technically stated, the human being is an organism. But the human being is also a personality; that is to say, an organism that talks, reads, thinks, wears clothes, enjoys such activities as smoking, dancing, and attending theaters, and perhaps follows some business or profession. No psychologist doubts for a moment the existence of a wide gap between the highest type of infra-human animal, the chimpanzee for example, and the normal, adult, civilized human being; yet the chimpanzee and man at his greatest degree of intellectual development show fundamental similarities in mental activity and in behavior. It is one of the purposes of psychology, then, to show that the human organism and the human personality are one and the same living being.

Human Beings and Apes. Usually the visitor at a zoölogical garden who becomes interested in watching the primates notes their resemblances to, rather than their differences from, human beings. And professional psychologists, when they survey the entire repertory of responses made by these infra-humans, tend to do the same. Thus, Yerkes (16) describes the outstanding traits of apes: they behave in general like spoiled children; they are selfish, greedy, and cruel; they

are sullen, and given to outbursts of temper; they clearly manifest such primitive emotions as anger, grief, love, jealousy, and depression; they are affectionate and they like to be petted by their human friends. They are literally "almost human."

But notice some of the differences: so far as we know, apes do not worry about their social status in the organic world or their prospects of dying; they do not suffer from complexes and they are not intrigued by rituals; they are not bothered by conventionalized morals; and they are not given to day-dreaming. Apparently, they live in the present, with little concern for the past and still less for the future. Judged by human standards, they are practically incapable of symbolic thinking and of vicarious living.

Human *versus* Animal Nature. These comparisons between apes and humans call attention to the fact that psychology, like any other science, deals largely with principles or abstractions. A principle is merely a general statement that applies to a number of phenomena; the scientist observes these separate phenomena and abstracts from them some characteristic which they have in common. By "human nature" is meant, therefore, such ways of thinking, feeling, and acting as are shown by all human beings; while animal nature, as opposed to human, obviously comprises the mental and emotional processes and forms of behavior which characterize all animals below man. Here indeed is a wide range of organisms; hence we must remember that "animal nature" is a generic term which includes ameba nature, rattlesnake nature, chimpanzee nature, and the like.

Relatively few principles are common to the behavior responses of the ameba, the chimpanzee, and the human; on the other hand, many principles underlie the responses of apes and of humans. However, it is usually assumed in introductory psychology that the principles which apply to the entire range of organic life are more fundamental than those which govern

any part of this range. Yet the psychological comparisons which interest most people are the more striking ones, such as those made between ape and man; and as the comparisons embrace more species they frequently become less personal and tend to lose their popular appeal.

Such considerations enable us to distinguish between *general psychology* and a special branch of this science known as *social psychology*. The latter stresses the purely social aspects of human behavior, such as man's use of language and his many other modes of interaction both emotional and otherwise; and it tends, therefore, to contrast human with infra-human behavior.

The Process of Comparing. In making comparisons among kinds of responses or among organisms, we should distinguish as sharply as possible between abstractions and analogies. In particular, we must not be misled by descriptions of animal social life furnished by certain naturalists. It is significant that these writers find highly socialized animal colonies not among the most intelligent mammals but among insects. This would imply that the organisms occupying the lower extreme of the animal scale are highly socialized while those in the upper extreme are less socialized. The tendency of paramecia to live in colonies really bears little more than an imaginary resemblance to the gregarious proclivities of human beings.

It is not easy to establish standards of valid scientific inference. In 1894 Lloyd Morgan formulated his famous canon which was to the effect that "In no case may we interpret an action as the outcome of the exercise of a higher psychical faculty, if it can be interpreted as the outcome of the exercise of one which stands lower in the psychological scale." This was well enough in those days of extravagant interpretations of the animal mind, but to-day there are those who look with equal disfavor upon rigid attempts to apply the simplest explanation. And there is a further difficulty: what to-day

seems to be a complicated and extravagant theory may tomorrow, after the addition of newly observed facts, turn out to be rather simple after all, and vice versa. Not a small part of scientific progress has followed this course.

Before making such comparisons as will enable us to formulate the principles of human and of animal behavior, we should note two important characteristics of the process of comparing. In the first place, as we have indicated, this process involves two logically opposed mental operations: observing or inferring resemblances, and observing or inferring differences. In the second place, both of the mental operations presuppose a common basis of comparison. Thus, we cannot compare the emotional responses of apes and of men without establishing the basis upon which the comparison is made. The two organisms are comparable in that both may show an accelerated heart rate while in a state of "fear"; that is to say, this particular phenomenon can be abstracted from the behavior responses of the two. But it is meaningless to assert that apes show the "rudiments" of the capacity to appreciate music and to think without defining exactly what is meant by appreciating music and by thinking.

Behavior and Its Organic Basis

We have defined psychology as the science of human and animal nature, and we have stated that it investigates both mental life and behavior. Now the behaviorists believe that all mental life can be reduced to muscular and glandular activity, but we may ignore their contention for the present: our point is that *all psychologists are interested in the behavior of organisms,* that of man included.

The term *behavior* refers to the entire range of activities manifested by the organism. Laughing, crying, breathing, sneezing, withdrawing the hand when it has been painfully stimulated, grasping and manipulating objects, feeling objects with the fingers, walking, talking, focusing the eyes upon ob-

jects, reading, putting the hand behind the ear in order to hear better, playing the piano, and writing a book are examples of behavior. It is fairly plain that the only non-behaving organism is the dead organism.

The Morphological Basis of Behavior. The activity of an organism is determined primarily by its anatomical and physiological organization. To illustrate, birds fly because they have wings; dogs bark because their vocal apparatus renders it possible for them to do so; human beings are enabled to laugh, cry, talk, and gesticulate by virtue of their anatomical equipment. The expression "animal nature" refers in the main to the characteristic behavior tendencies of animals made possible by their bodily structure. In this sense it is "natural" for the squirrel to eat nuts and for the carnivorous beast to capture and devour its prey. Likewise human nature is basically a product of the human bodily constitution. The behavior of all organisms from ameba to man is thus innate in so far as it is determined by structural and physiological factors.

It follows that neither structure nor function can be studied as a separate phenomenon. The subject-matter of psychology, in so far as this science is concerned with behavior, is always man or animal with a definite structure functioning in an environment. The plow turns the furrow, the lathe makes objects, and the airship flies through the air. Each of these machines, by virtue of its structure, accomplishes one task and one only. The plow cannot be used in the manufacture of objects, in the way that the lathe can, nor can it fly through the air and carry passengers.

But no two plows of the same make, no two automobiles of the same model, and no two human beings, even identical twins, are exactly alike. Depending on our scientific or practical interests, structural differences within any one species may or may not be important. Of two men, both working in a factory and making the same product, one may be six feet

tall, forty years old and of Scandinavian ancestry, the other, five and a half feet tall, thirty years old and of Latin ancestry. The foreman may rate them as equal as far as their manual skill is concerned, but with their structural differences we must assume that they perform their tasks in somewhat different ways. And so with the rest of their activities; we may be able to work out a complete parallel between their various psychological acts and still find that each performs these acts in a way slightly different from the other. We have the task, then, of determining the limits within which observable structural differences do not affect significantly differences in behavior. And the word "significantly" is an important one here, for it may be of great interest to the psychologist to know how two men, structurally different, adjust their movements in performing essentially the same act. The field of psychology which deals with differences among individuals or groups is known as *individual psychology.*

Behavior Mechanisms. In describing the anatomical structures of an organism which are responsible for its behavior, psychologists and physiologists usually distinguish between (a) the organs of stimulation, and (b) the organs of response. They regard the nervous system—that is to say, the brain and the spinal cord, and the nerves themselves—as a device for connecting the two systems of organs.

The Receptors. The organs of stimulation are commonly known as sense organs, but since their function, as regards behavior, is to receive forms of stimuli, they are more properly called receptors. Most writers classify the receptors into three groups, as follows: (1) the exteroceptors comprise (a) the distance receptors—that is to say, the organs of vision, audition, and olfaction, and (b) the contact receptors, or the cutaneous sense organs; (2) the proprioceptors consist of (a) the kinesthetic sense organs, located in the muscles, tendons, and joints, and (b) the organs of equilibrium, found in

the semicircular canals of the ear; (3) the interoceptors are the sense organs found in the viscera of the body.

In order to understand the specific functions of the various classes of receptors, it is necessary to know what is meant by the *somatic* and the *visceral* parts of the body, respectively. The viscera consist of the digestive, circulatory, excretory, respiratory, and reproductive systems of the body. Most of the visceral organs of a fowl are removed when it is drawn for cooking. The viscera are directly controlled by a division of the nervous system called the autonomic nervous system. Visceral organs such as the stomach, kidneys, heart, and lungs must not be confused with the visceral receptors or sense organs belonging to this system. The latter are sensory nerve structures, microscopic in size, located on or near the visceral organs. The somatic part of the body includes primarily the skeleton, the skeletal muscles, the skin, the cerebrospinal nervous system, and the receptors directly connected with this system. Somatic receptors are sensory nerve structures found on the body surface, on the joint surfaces, in the muscles and tendons, and in one case, in a bony cavity within the head. The responses elicited by stimulation of visceral receptors are glandular secretions and movements of visceral organs, while the responses elicited by somatic receptors are involved in the organism's reactions to its environment.

The receptors are thus classified in terms of their functions. Both the physiologist Sherrington (9) and the neurologist Herrick (6) have grouped receptors in this way. The following table represents a combination of their respective systems:

A. The Somatic Receptors

I. Exteroceptors

1. Distance receptors
   (a) Organ of vision—the eye
   (b) Organ of audition—the outer ear, middle ear, vestibule and cochlea of inner ear

(c) Organ of smell (also an interoceptor)—olfactory epithelium of nose

2. Contact receptors—the cutaneous sense organs
   (a) Organs of touch and pressure
   (b) Organs of heat
   (c) Organs of cold
   (d) Organs of pain (in addition to interoceptors for visceral pain)

II. Proprioceptors

1. Organs of position and equilibrium—semicircular canals, saccule and utricle of the internal ear
2. Organs of kinesthetic functions
   (a) Organs in muscles
   (b) Organs in tendons
   (c) Organs in joints, or on articular surfaces

B. The Visceral Receptors

III. Interoceptors

1. Receptors of the digestive system
   (a) Organs of smell (listed above)
   (b) Organs of taste—taste buds on tongue and pharynx
   (c) Organs or sensory cells of hunger—in stomach
   (d) Organs or sensory cells of thirst—in mucous membrane of pharynx.
   (e) Organs or sensory cells of nausea—in stomach
2. Receptors of circulatory system
3. Receptors of respiratory system
4. Receptors of reproductive system

Physical Stimuli and the Receptors. The receptor is a receiving device. It receives some form of physical stimulus for which it is structurally adapted. The eye receives light waves; the ear receives sound waves; the organ of smell receives gaseous particles; the organ of taste receives food particles in solution; the cutaneous receptors receive thermal, mechanical, and chemical stimuli. Still other forms of stimuli are described subsequently in this chapter.

The fact that a receptor receives stimuli is the first consideration involved in ascertaining its function. Having acted

upon the sensitive cells in the receptor, the stimulus has completed its task. It then disappears or moves beyond the range of sensitivity of the organism; or the organism moves away from the stimulus; or perhaps the stimulus if continuous is regulated or shut out by the receptor itself. An example of a receptor regulating a continuous stimulation is found in the contraction and dilatation of the pupil of the eye. If the stimulus is excessively intense, the organism makes convulsive responses designed to eliminate it or scatter its physiological effects. No receptor can withstand an intense stimulus indefinitely, for it eventually becomes fatigued, and it may suffer permanently from the overstimulation.

The Effectors: Somatic and Visceral Muscles. The effectors fall into two classes, somatic and visceral. The somatic effectors are the muscles or the muscle-bone units of the body. There are approximately 200 bones and 500 skeletal, or striped, muscles in the human body. In one kind of response mechanism, the striped muscle connects with itself or with movable parts of the body. The muscle surrounding the mouth cavity, the muscle of the eyelid, the exterior muscles of the eyeball, and the muscles of the scalp are examples of this kind. In the second and more typical kind of response mechanism, the two ends of the muscles are attached respectively to two articulating bones. This mechanism is therefore a lever. Muscles are attached to bones by tendons. Both kinds of response are due directly to contractions of the muscle itself, caused by nerve impulses discharged upon the individual muscle cells or fibers.

The typical visceral muscle is smooth in the sense that its fiber does not have the striated or striped appearance of the skeletal muscle. The smooth muscle fiber is shaped like a spindle and it contains, as distinguished from the striated muscle, only one nucleus. Smooth muscle tissue is found in the alimentary canal and other visceral organs, the blood vessels and lymphatics, the bronchial tubes, the internal muscles of the eyeball, and the muscles attached to the hair follicles.

Contrary to what would be expected, however, the heart muscle is striated. The smooth muscles are the non-skeletal muscles of the body. Very frequently skeletal and non-skeletal muscles respectively are called voluntary and involuntary, but these terms are confusing and should be avoided.

The two distinguishing characteristics of smooth muscle contraction are sluggishness of movement and the tendency to maintain muscular tone. Whereas sudden movements are more useful in the skeletal muscles, because they are responses to the external environment, slower reactions are better adapted for such organic processes as digestion. When sudden contractions of the smooth muscles occur they indicate an unusual visceral condition.

Somatic Muscle Effectors and Their Accessory Parts. Although the muscle-bone mechanism is usually considered to be the motor unit of response, it should be pointed out that certain accessory structures are instrumental in making the actual responses. Thus, the teeth and claws of the tiger, and even its vocal apparatus, belong to its response equipment. Note, too, that human reactions differ from the responses of animals in that they involve the use of tools. The tiger's muscular equipment enables it to extend its claws, while that of the human is involved in his use of a gun or dagger. Functionally, the two are comparable.

The Effectors: the Duct Glands and the Endocrines. The glands are secreting organs of the body. Some of them discharge their secretions through ducts into body cavities or on the body surface while others manufacture secretions that are taken directly into the blood stream. The former are the duct glands and the latter are the ductless glands or the *endocrines*.

Among the chief glandular effectors possessing ducts are the salivary glands, the glands of the stomach and intestine, the pancreas, the liver, the kidneys, the sweat glands, and sebaceous glands of the skin. Some of the digestive glands also

have endocrine functions. While the duct glands are primarily concerned with vital physiological processes, they are, as Watson points out, indirectly of great psychological interest in that their activities are in part modified by external stimuli. For example, evidence shows that the flow of gastric juice can be accelerated by the sight of objects that have been associated with pleasant meals. In other words, their responses become associated with extraneous stimuli and thus contribute to the general tone of the organism.

The endocrines vary in size and appearance, and in function. The *pineal body* is a small structure situated on the posterior surface of the brain stem between the cerebral hemispheres. It attains its greatest glandular development during childhood, and seems to inhibit excessive growth of the skeleton and the reproductive organs. The *pituitary* body is lodged in a bony cavity at the base of the brain. It is divided into two lobes, an anterior and a posterior. Hyperfunctioning (excess functioning) of the anterior lobe is supposed to produce gigantism by stimulating the growth of the skeleton; functioning of the posterior lobe exercises a tonic effect upon the smooth muscles, promotes secretory functions of several other glands, and facilitates the changing of glycogen into sugar. Little is known about the *thymus* gland, which is situated in the chest below the neck near the upper part of the breast bone. Since it atrophies after puberty, it is assumed to have an important function during early life. The *thyroid* and *parathyroid* glands are in the neck. Removal of the parathyroids is usually fatal. Removal or insufficient functioning of the thyroid produces the physical and mental symptoms of cretinism, including retarded growth, drying of the skin, loss of hair, accumulation of fat, and mental deficiency. A tendency towards this condition in the adult, caused by a goitre, can be overcome by administering thyroid substance. Hyperfunctioning of the thyroid produces the nervousness, protruding eyeballs, rapid pulse, increased perspiration, and other symptoms of the

exophthalmic goitre. The physiologist Crile (4) points out that these are the characteristic fear symptoms. The active principle of the thyroid autacoid was isolated recently and named *thyroxin.* It contains 60 per cent iodin, and it is administered to patients suffering from thyroid deficiency. The *adrenal* glands are two small pea-shaped bodies situated above the kidneys. Each is divided into two parts, the cortex and the medulla. The cortex is little understood but the medulla secretes an autacoid; adrenin, that liberates stored sugar in the blood and produces increased blood pressure. The physiologist Cannon (3) states that these conditions prepare the organism for violent physical exertion, and that they prevail, as the result of increased adrenal function, during the emotions of fear and rage. The *sex* glands in the male secrete an autacoid that is responsible for the appearance of secondary sex characteristics—the masculine voice, the beard, etc. When administered at the onset of senescence this autacoid seems to produce temporary rejuvenation. The sex glands are functionally related to some of the other endocrines. In fact, the functions of the various endocrines overlap and modify each other in ways not yet clearly understood.

The Stimulus-Response Principle. The foregoing sketch of the anatomical-physiological equipment of the complex organism suggests that this organism is a responding machine. It is a living machine, to be sure, and one which in Herrick's (7) opinion does not behave according to principles which govern non-living machines; but it is a machine in the sense that it consists of effector-receptor mechanisms.

The stimulus-response principle refers to the relationships between the activity of the organism and the factors causing this activity or behavior. The causative factor is the stimulus and the behavior is the response. Such behavior is shown by the simplest forms of animal life. As animals become more complex structurally they react proportionately to groups of stimuli rather than to stimuli in isolation, such groups being

factors that are known as *situations*. Thus, while lower organisms, the ameba for example, respond to light, heat, gravity, contact, and chemical substances, man reacts to automobiles, thunder-storms, symphony concerts, books, sermons, dinners, animals, his fellow creatures. A situation is not merely an aggregate of stimuli, however, for these stimuli inaugurate sensory nerve impulses that are organized in the brain before they cause action. The chief factor in this organizing is past experience, represented by neural "traces." Hence, in examining a locomotive, an individual reacts not only to visual, auditory, olfactory, and thermal stimuli, but to the object itself. These stimuli function by arousing nerve mechanisms in his brain, mechanisms that represent his previous experience with locomotives. Higher animals react to situations rather than to stimuli because their reactions also are modified by their past experiences.

The behavior of higher animals and of man consists chiefly of complex and interrelated acts. As we have just intimated, stimuli come from *within* the body as well as from without, requiring systems of internal sense organs or internal receptors. Such stimuli are variously known as organic states, drives, emotions, and motives. Moreover, many of these states are both stimuli and responses. Anger is a response, aroused, say, on the occasion of an insulting remark; but it is also a stimulus in that it prompts to action the person in whom it has been aroused. Since many internal stimuli are more or less permanent or recurring, as is true of hunger and of a grudge, the resulting behavior is likewise permanent or recurring. Frequently a response made to a stimulus furnishes the stimulus for an ensuing response. This occurs when the pouncing reaction made by the cat to the running mouse results in the capture of the prey; for the mouse, when held in the cat's mouth, becomes a combined touch and taste stimulus for further and different conduct. In many other respects stim-

ulus-response behavior is complicated, particularly in the social life of man.

The Integration of Response Units. The act of behavior that results when a relatively simple group of nerve impulses go from receptor to effector is called a *reflex,* or a *reflex act.* Examples are hand-withdrawal as the result of painful stimulation, the pupillary reflex to light in the eye, respiratory reflexes such as sneezing and coughing, circulatory reflexes such as blushing, paling, and heart acceleration, reflexes of the skeletal musculature such as balancing, grasping, waving the arms, extending the fingers. The flow of saliva and tears are glandular reflexes. Corresponding to the two kinds of effectors, reflexes are motor or glandular. Reflexes vary greatly in complexity. The importance of the principle underlying reflex behavior will be brought out repeatedly in this text.

But relatively few responses are effected by simple, independent reflexes; and in fact, such reflexes are seldom found in the normal, intact organism. Most of them are organized or integrated into complex responses. Even the few that escape complete integration, such as the pupillary reflex, the wink reflex, sneezing, coughing, and the various pain reflexes, vary according to the changing condition and experience of the organism. The new-born infant is decidedly something more than a mere bundle of reflexes.

Integrations of simple, stimulus-response mechanisms are known as patterns, or pattern reactions. They are broadly classified as *simultaneous* or *successive.* Fear is primarily a simultaneous pattern reaction. This pattern consists of certain characteristic unit reactions, such as cold perspiration, staring eyes, trembling, "goose-flesh," shrinking, palpitation of the heart, turning pale, and various other autonomic reflexes. Successive integrations are illustrated by such activities as running, typewriting, and talking. The distinction between simultaneous and successive responses is relative, since the majority of patterns show both characteristics.

The chief factor responsible for the integration of simple responses into patterns is the tendency of many responses to bring additional stimuli in contact with the receptors. In the *chain reflex* a response automatically furnishes the stimulus for a succeeding response. An illustration is found in the food-getting activity of animals. When an insect alights a foot or so in front of a lizard, the eyes of the reptile are stimulated, causing it to advance toward the source of the stimulus. This act intensifies the visual stimulation by increasing the size of the retinal image. When this image attains a certain size it elicits a new response: the lizard's tongue darts out and captures its prey. This response provides new stimuli for the lizard, namely, the tactile and gustatory stimulation on its tongue. These arouse the swallowing reflex and in turn the act of swallowing furnishes the stomach with food. As the food is being digested it is forced through the alimentary canal, stimulating the digestive reflexes in sequence. Thus the entire series of responses, including the digestive reflexes, constitutes a chain of reflexes displayed successively.

The *circular reflex* or circular response is a special type of chain reflex in which the proprioceptive, afferent impulses started by a muscular act travel to the central nervous system only to be redirected back as efferent impulses which reënforce or maintain the original act. In the act of holding a pencil while writing, the proprioceptors of the hand and fingers are stimulated by the tense condition of the muscles involved, and this stimulation automatically tends to perpetuate the act. Frequently a circular response directs exteroceptive stimuli upon itself. As Allport (1) explains, this phenomenon is illustrated by the young child learning to talk. Each time the child says "da," its ears are stimulated by its own voice; and this auditory stimulation, combined with the circular proprioceptive stimulation from the vocal apparatus, prompts it to repeat the syllable indefinitely. In stuttering, this tendency is manifested to an abnormal degree. Since the proprio-

ceptive system functions in all somatic activity, integrations of the circular type are component parts of all adjusting processes.

Purposive or Adaptive Behavior

There are psychologists, however, who contend that the stimulus-response principle fails to describe or explain behavior. In their opinion, this principle implies that the organism is *merely* a machine which responds automatically to stimuli. Their standpoint is expressed by Thurstone's (10) claim that the organism, human or infra-human, actually seeks certain stimuli and avoids others. In general, as they view behavior, the organism strives for ends which are calculated to promote its physical or social welfare.

Some Examples of Purposive Behavior. After due deliberation, a university undergraduate student decides to become a physician; and, acting upon this decision, he eventually spends several years in a medical school, serves his interneship, and begins to practice medicine. Here is an unambiguous example of purposive behavior; that is to say, behavior which through a period of years was indubitably goal-seeking in character.

Lest it be concluded that goal-seeking is something unique in human conduct, consider a case of animal behavior. A puppy, surrounded by a group of boys, is chasing a ball which is rolled from one member of the group to another. One of the boys conceals the ball, whereupon the animal noses around excitedly until it either finds the object or discovers a substitute. Now according to the ordinary meaning of words, the animal is not merely responding to stimuli: notice that it seeks an object not present to its senses. It plainly wants the ball and attempts to find it.

Nor is purposive behavior or goal-seeking any the less in evidence among lower organisms. The following is Wheeler's (14) statement to this effect: "That the lower animals imagine the anticipated goal can not be demonstrated directly, yet

it is obvious from observation that they behave with respect to a goal. The hungry animal hunts for food; the frightened animal flees from the odor of an enemy coming down the wind, although the enemy is not seen; the bird flies back to its young and the bee to its hive. Presumably the hungry rat, searching for food, perceives the goal in some lowly fashion; possibly he imagines it."[1]

As a final argument, it has been asserted that the behavior of the wide-awake organism is *always* purposive. If no tangible goal is in sight the organism will create, discover, or adopt one. As long as the puppy is in a playful mood it will find some object suitable for this purpose; remove the ball, and it will soon find a stick or a shoe. Even a piece of meat thrust under its nose may not deter it from playing. Imprison an adult human being, thereby depriving him of social and intellectual stimuli, and if nothing else offers itself, he will count the exact number of stones in the walls of his cell. He must work upon some self-assigned task; he must attempt at least to accomplish *something*.

The Physiological Basis of Adaptive Behavior. The concept of purposive behavior is derived from the fact that all organisms have physiological needs, often called *tissue* needs. In higher organisms, and especially in man, these are known as *desires*. All tissue needs represent certain fundamental properties of protoplasm. In order to maintain life, organisms require certain chemical elements in the form of food, air, and water. Furthermore, within limits which frequently are quite narrow, the organism requires an optimal body temperature, and from various glands of the body come secretions which regulate certain metabolic processes. From one point of view, then, the life of the organism may be considered as a continuous process of maintaining or attempting to maintain a satisfactory physiological equilibrium. Adjusting behavior occurs when any pressing tissue need is not satisfied. The hun-

[1] *Op. cit.*, p. 242.

gry animal will eat food, he will shiver or crawl into a hole if cold, and he will seek a mate when he is physiologically motivated to do so.

It is the persistence of goal-seeking behavior through variable circumstances that defines its purposive character. If the means to the goal are altered, we find the behavior of the organism altering in a corresponding way. It is easier to predict that an animal will find food than to predict how he will discover it. The latter depends upon the nature of the present situation and upon the past history of the animal. This variability has been called the *docility* of behavior. We find, however, that this docile or variable behavior is not entirely unpredictable. Depending upon what we know of the past history of any animal, we can expect him to exhibit fairly definite behavior patterns. We know that animals tend to take the easiest way to their goals. For example, this is shown by their taking the shortest route to food placed at the far side of a system of complicated pathways. Comparable behavior is shown by human beings, for we may consider much of our modern economic development as the effort to find easier and better means to the satisfactions of life.

The Morphological Basis of Adaptive Behavior. It should be emphasized, in behalf of the psychologists who criticize the stimulus-response principle, that the receptor-effector classification of bodily mechanisms is based upon functional as well as on anatomical considerations. The exteroceptors serve to orient the organism with reference to its environment. The organ of vision enables it to make accurate, preparatory responses in the world of space. It is not mere coincidence that certain words used to describe phases of intelligence are visual terms: "foresight," "insight," "seeing into a situation," and the more poetic term, "vision," suggest the ability of the organism to anticipate and prepare for future exigencies. Audition and olfaction likewise arouse preparatory responses. The cutaneous receptors, on the other hand,

bring the organism into immediate contact with its environment. The proprioceptors are involved chiefly in motor coordination: without their aid, the organism, at best, would be capable only of clumsy and poorly-directed movements. The responses elicited by stimulation of the interoceptors are, as we have said, glandular secretions and movements of visceral muscles. These responses serve the purpose of reporting physiological *needs* to the central nervous system. When the organism is in a state of hunger, for example, its stomach muscles contract at intervals in a distinctive way. The conscious effects of these contractions are known as hunger pangs. And naturally, the organism which experiences hunger pangs explores its environment in quest of food.

The Behavior Cycle. In an account of behavior which stresses adjustment-securing activities, it is preferable to substitute a functional description of the typical behavior act for the familiar stimulus-response formula. Such a description calls attention to the fact that the unit of behavior is a cycle. Briefly stated, the cycle runs as follows: (1) The temporarily adjusted organism is an *inactive* organism. Having no tissue needs or physiological demands which require overt behavior for their satisfaction, the organism rests. Thus, the petted and pampered family cat spends an amazing amount of time in sleeping; for that matter, so does the Sybarite. (2) As physiological needs develop, the organism becomes restless, and when they become insistent, it explores its environment, seeking objects and situations which will relieve or satisfy its cravings. Wada (12) found that hunger pangs in sleeping human beings are accompanied by restless movements and by a gradual return to consciousness. Cannon's well-known experimental findings have some bearing upon this phase of the cycle. According to this investigator, the sympathetic division of the autonomic nervous system has an emergency function. The symptoms of excessive sympathetic innervation, such as increased heart action, rapid breathing, dilatation of the pupil,

and secretion of adrenin, are manifested when the organism faces a crisis; they indicate a state of preparation for activity. In general, functional psychologists hold that mental and emotional processes are most active when the organism encounters difficulties. (3) Its needs being satisfied, the organism again becomes quiescent. Its overt activities cease and its physiological processes become relatively inert. Thus the cycle is completed.

The Instinct Hypothesis

It has long been supposed that the organism *inherits* tendencies to behave in certain ways calculated to satisfy its needs; specifically, according to this supposition, the organism inherits brain connections or centers which prompt it to provide for its own interests. Among the innate behavior tendencies which have been credited to the higher organisms are self-preservation, curiosity, pugnacity, mating, fear, and the impulse to select and ingest certain foods—tendencies which undoubtedly are useful to the organism. This explanation of behavior is known as the instinct hypothesis.

From the standpoint of this hypothesis, the food-getting instinct drives the organism to seek and devour edible substances; the sex instinct provides for its reproductive functions; the gregarious instinct draws members of the same species together; and, more specifically, the nest-building instinct prompts the bird to construct its home.

A General Criticism of the Instinct Hypothesis. However, modern psychology tends to discredit the instinct hypothesis on the grounds that it does not explain behavior. It will be noticed, in the first place, that each of the accounts of behavior just made is purely descriptive and not explanatory. Each is tautological. For instance, one of the above statements merely tells us that members of the same species flock together because they flock together.

If this criticism is well taken, "instinct" is open to the ob-

jection which all psychologists urge against the term "intuition." The latter has been dropped from scientific psychology because of its implication that the experience which it designates is *unanalyzable* as well as unanalyzed. Thus, a person is alleged to read the character of another individual by "intuition"; that is, by employing some unanalyzed and mysterious power or gift. As a matter of fact, his judgment is likely to be a blind prejudice, possibly a response transferred from some individual whom he has previously known. In many instances it can be accounted for, and in any event it is presumably the product of experience. In much the same way, instinct usually refers to an activity which, as we show below, is actually capable of analysis. The psychologist Kuo (8) has voiced this criticism by charging that the instinct hypothesis makes for a *finished* psychology. In other words, by substituting verbal labels for detailed analyses it discourages inquiry and investigation.

Instincts Are not Inherited Responses. When we approach the study of either human nature or animal nature from the genetic point of view, we see that the *original* activity of the individual involves something more than the functioning of inherited brain connections. Consider the alleged food-seeking instinct: Why does the organism eat? Is it in order to preserve life? The actual cause is a change in the physiological condition of the organism that results in rhythmic contractions of the stomach. Nerve impulses initiated by these contractions constitute the physiological basis of hunger sensations. In the absence of this condition in some degree, the feeding response does not take place. Any one who has ever attempted to force an infant to finish its bottle of milk will testify that the feeding movements cannot be coerced. Note that the stimulus from the physiological side is a series of reflexes; and on the response side also we find a reflex or a chain of reflexes. This response is not evoked until food is brought into contact with the mouth parts. In mammals this includes

sucking movements, also reflex in mechanism. Consequently, the only part of the total feeding behavior which can be described as native is of this reflex sort. To recapitulate: as regards the stimulus, we have the organic state of hunger and the presence of food in the mouth; and on the response side, we have the series of chain reflexes which constitute the processes of swallowing, digesting, assimilating, and eliminating the ingested material. All else ordinarily associated with feeding is learned. The infant does not possess an instinct that drives him to seek his mother's breast: he is put there and conditions are so arranged for him that suckling ensues.

When in the appropriate physiological condition the infant will indulge in the same movements as soon as *any* tactual stimulus not particularly disagreeable or painful in character is applied to the lips. For instance, so far as any instinct is concerned, he will respond to a finger or a rattle. The fact that on a future occasion he relinquishes the rattle in favor of the bottle is due to his experience and not to his instinct. In other words, the only part of food-getting that is truly "instinctive" is the tendency to swallow when food is in the mouth.

Furthermore, we have no evidence to support the popular notion that instinct informs the organism what kind of foods to take. A young chick will peck at any small object indiscriminately—an insect, a piece of red pepper, its brother's eye. As we have just said, the human infant is notorious for putting anything in its mouth. In the adult human or animal, such habits as have survived through training and experience determine what is eaten. Because we feel like eating something salty is not necessarily proof that our physiological supply of sodium chlorid is below par. In fact, as drug addicts prove, acquired tastes are sometimes far stronger than innate or "natural" tastes.

Nor is there any point in designating the functioning of food and hunger reflexes by such a term as the "instinct of self-preservation." Psychologically, an infant cannot be said

to seek food instinctively in the sense of responding to some inborn urge to maintain life. His physiological constitution impels him to indulge in restless movements whenever his nutritive equilibrium, or the state of balance in his digestive system between food needs and food supply, is disturbed. These movements persist until the equilibrium is reëstablished as a result of the administration of food by others. In the course of time a complex series of feeding habits is built up. Even the definite recognition that the hunger disturbance calls for food is a learned and not a native factor of the individual's nature. To say that the starving man steals a loaf of bread because of the instinct of self-preservation or the food-getting instinct is psychologically false. He may, so far as the facts are concerned, actually prefer not to preserve his life. He steals the bread because he has learned that bread will restore his gastric equilibrium. The only part of this completed act that is instinctive is what takes place from the moment the bread reaches the mouth; all else is acquired. We may conclude that so far as the term instincts is concerned, it only describes certain broad categories of behavior and leaves out of account all analysis of how any particular instinct functions and becomes modified through experience. And we must remember that even if there are any such innate instinctive tendencies to behavior, their number is certainly far less than is popularly supposed.

The Integrative Process

The behavior facts so far presented fail to provide for the "inner" activities of the organism. Neither the stimulus-response concept nor the behavior cycle concept adequately provides for the animal's ability to organize and utilize *the effects produced upon itself through its contacts with the environment.* That such organizing occurs is established by a fact known to every boy who owns a pet—*viz.*, the fact that animals can *learn.* Whether they profit from their experiences

or not, animals show unmistakable indications of the capacity to "remember" past experiences. Then, animals organize present experiences: they react to objects and situations, and not merely to sound waves plus visual stimuli plus touch stimuli. In other words, the animal perceives objects and to a certain extent shows "insight" as regards the significance or meaning of objects and situations. And we must not overlook the obvious fact that at least the human animal can *think*.

This inner, organizing capacity of the organism is known as the integrating process. Its principles are described at some length in Chapter II; for the present, we are interested in its *nature*. As we have intimated, the behaviorist reduces this process, including the process of thinking and reasoning, to muscular and glandular activities, while the so-called "introspective" or "mentalistic" psychologist thinks of it as consciousness, mind, or mental activity. The remainder of this chapter is devoted to a short account of these respective views.

Psychology as the Science of Behavior

As the behaviorist says very truthfully, the first attempts at psychologizing about men and animals totally ignored the possibility of a naturalistic explanation. All higher organisms were supposed to possess spirits or demons, many of which were evilly disposed. Thus epileptic and insane people were possessed of evil spirits. These unfortunate victims of disease were frequently flogged or otherwise tortured so that the wicked spirits would be driven from their bodies. In certain cases, however, the spirits commanded respect and awe. People who now would be recognized as hysterical patients were thought to speak in unknown tongues and to possess transcendental knowledge. Occasionally they were hailed as prophets. To-day such patients are treated by physicians with psychological training. The doctrine of the transmigration of souls is another variety of spiritism or demonology. According to this belief, the death of the organism liberates

the spirit to seek another, newly-born organism, as its home. The souls of animals as well as human beings transmigrate into human bodies, thus accounting for real or fancied resemblances between men and animals. All of these beliefs grew out of the attempt to explain certain facts of behavior.

When scientific psychology came into being, less than a century ago, it turned to biology for its fundamental principles. It sought an explanation of human abnormal behavior in physiology rather than demonology; and likewise it looked to physiology for an explanation of normal behavior. Of course this move did not preclude the development of many erroneous notions, for the simple reason that biology itself was still under the spell of spiritism. For instance, some psychologists taught that conscious states or memories are inherited, and that they are passed on from one generation to another. Dreams of falling or of gliding through the air without physical support were explained as vestigial memories going back to our animal ancestors. The modern biological standpoint in psychology was adopted when this doctrine of innate ideas was discarded, and the behaviorist simply extends the principles of biological explanation to all psychological phenomena.

The Behaviorist's Analysis of Thinking. The most important, and possibly the most difficult, task of the behaviorist is to explain the processes ordinarily known as thinking and reasoning. Let us ascertain, then, how he accomplishes this task.

In the first place, he points out that the person who is thinking is also acting or behaving. When, for example, we lie down on the bed or couch, we may either fall asleep or start thinking about some problem. If we are drowsy, we may relax until we partially or completely lose "consciousness." If, however, we begin to think intensively, we show all indications of muscular activity. In fact, we are likely to jump up from the bed and begin pacing the floor. In addition, we may

scowl, scribble marks or notes on paper, smoke one cigarette after another, and show additional signs of somatic and visceral activity.

But this in itself does not describe or explain the thinking process. According to many behaviorists, we think largely in terms of *words*. Watson (13), for instance, defines thinking as the process of talking to oneself. While dressing, a man drops his collar button. He is in a hurry to catch a train. With swift movements he surveys the floor, but the button is not in sight. Accordingly he gets down on his knees and peers underneath the bed, the chairs, the bureau, and other bedroom furniture. The button is not to be seen. Muttering imprecations he jumps up, glances at his watch and perceives that his time is limited. He begins to ransack the room for another button, but to no avail. Finding this a futile endeavor, he renews his search for the button he dropped. Again he looks all over the floor and underneath the furniture. In baffled fury he begins to move the dresser away from the wall in order to make sure the button is not tucked away in a remote corner. Suddenly he decides that he might have a shirt with a collar attached. A hurried examination of his wardrobe shows that this too is a fruitless clew. He returns to the job of moving the dresser when he chances to glance in the direction of the partly opened closet and spies the button just barely inside of it. His search is over and his problem solved.

Let us assume that his search ended by discovering that he had a shirt with a collar attached. In this case we might say that an element of thinking entered into his solution. In fact, in telling of his experience the man would say, "As I was about to move the dresser, the *thought* came to me that I might have a shirt that didn't require a collar button." When we consider what takes place when such *thoughts* come to us, under the simple conditions of our assumed problem, we may succeed in securing an understanding of the nature of thought.

It will be to our advantage, therefore, to continue using the given illustration of searching for the lost button by way of indicating what takes place when we are *thinking*.

After the first preliminary survey of the floor, the man pauses in the midst of his active search, let us say, and remains standing still for a few minutes. His eyes are seemingly focused on some distant point; his brows are knit and the muscles of his face obviously tense. An outside witness would unhesitatingly say that the man was thinking. Yet so far as his overt movements are concerned, he seems to be doing nothing. Nevertheless, according to the behaviorists, the man is really active while thinking. He is carrying on the search for the lost button, but instead of moving the furniture about he is moving *verbal* or *word symbols* such as "bed," "dresser," "chair," about. He is also conducting the search by means of abbreviated gestures that the casual observer does not notice. These gestures are also *symbols*. In other words, the man is struggling with his problem by means of language mechanisms. He is talking to himself: "I've got to hurry. Train leaves in thirty minutes. Sure that button is on the floor. Heard it fall. Rolled some distance. Guess I'll look under the bed. No, it couldn't have gone that far. Now let's see, I was standing right there" (eyes move in direction of corner and slight increase in tension of arm and finger muscles takes place as *if* he were about to point) "when I dropped it. Seemed that I heard it roll to left. Guess I'll move that desk aside. Couldn't have rolled that far though." In this fashion we can continue writing out the possible sequence of his talking or *thinking*. An astute observer would note the slight finger movements, changes in head position, shifts in the position of the eyes, and other movements of the bodily parts. These we take to be abbreviated gestures, as when a slight finger movement *represents* "moving the desk." All this time the man has said nothing out loud, nor has he moved from his original spot in the room. His talking has been of the sort we indulge

in when talking to ourselves: mere incipient movements and delicate adjustments of the organs of speech without actual utterance. His gestures may have been of the same incipient sort. Yet the man was reacting. The reactions consisted in *language* (words and gestures) reaction, even though they were going on beneath the surface and in incomplete fashion.

Emotions as Forms of Behavior. Similarly, the behaviorist reduces feelings, emotions, and motives to forms of visceral activity. As far back as 1884, William James and Carl Lange concluded, in substance, that emotion consists of the *consciousness* of bodily disturbance or commotion; they contended, for example, that "fear" is composed of the sensations caused by trembling muscles, rapid and spasmodic heart action, accelerated breathing, "goose flesh," etc. Now Watson simply goes a step further and says that the bodily disturbance *is* the emotion. From his standpoint, emotion is a form of visceral behavior.

Behavioristic psychology regards motives as forms of interoceptive stimulation. It assumes, therefore, that the stimulus-response formula provides for internal as well as external stimuli. Thus, the behaviorist Dashiell (5) defines "hunger" not as a conscious experience or hunger pang, but as the "vigorous contractions of the walls of the empty stomach." These contractions stimulate the interoceptors of the stomach; the nerve impulses inaugurated by the interoceptors reach the central nervous system and arouse the organism to activity. It will then ". . . keep in activity until its hunger is satisfied, and if obstacles to hunger are interposed it will show exploratory activity until it chances to surmount them." [1]

The Control and Prediction of Behavior. As Watson further explains, the stimulus-response principle is basically involved in psychological *prediction*. Knowing the response we infer the stimulus and knowing the stimulus we predict the response. The two possibilities become significant when we

[1] *Op. cit.*, pp. 234-235.

realize that science aims at, and is judged by, its predictive achievements. Our popular respect for astronomy is caused by the fact that astronomy is a highly predictive science; eclipses, for instance, occur on scheduled time. Many chemical phenomena are just as predictable. A greater margin of error is found in biological science, particularly in the applied phases of biology. In medicine, for instance, prediction is not always safe.

Since psychology is a biological and social science, prediction in that field has reached the same degree of accuracy attained by these sciences, but human nature is not the uncertain, intangible thing it is sometimes assumed to be, for otherwise social organization would be impossible. To "know" a person is to predict with a reasonable degree of accuracy how he will behave in a given situation. Furthermore, even insane behavior can be predicted: the psychiatrist knows his patients just as the teacher knows her pupils. In other words, human responses are reactions to the physical and social environment, and they tend towards uniformity because human organisms are structurally similar, while the environment, both physical and social, shows relatively little change. Human nature is much the same, in all ages and the world over.

Psychology as the Science of Mind

Ask the average man if he is a conscious being and his answer will be an unqualified "Yes." He will regard his own consciousness as a self-evident fact. Moreover, he will entertain no doubts about the consciousness of all other normal human beings, at least those who have passed the stage of infancy; and likely as not, he will extend consciousness far down into the animal scale. He may even suspect that the ameba has the rudiments of consciousness.

Now consciousness means awareness—the two terms are used interchangeably; hence we may well inquire, awareness of what? When asked this question, the average man will

answer it in terms of the *content* of his consciousness: In the first place, he perceives objects, situations, and relationships through the senses which we have classified as exteroceptive. Thus, when he is purchasing groceries he sees, feels, and smells objects, such as fresh peaches; he observes that all objects within his range of vision occupy space and show spatial relationships to each other—the meat-market, for instance, is in the back of the shop; he notices certain qualities of objects, such as their colors, sizes, shapes, and weights; and of course he hears sounds coming from moving objects. Among these sounds he distinguishes human voices; incidentally, he will understand fragments of conversations in the English language, but he may not know whether the two Mexican shoppers are quarreling or merely deciding upon what to buy. Secondly, his consciousness includes certain experiences which are definitely located within his own body: he is fatigued and hungry, and perhaps his shoes hurt his feet; in addition, he is emotionally upset because he is forced to stand in line before being waited on by the clerk. These experiences are obviously subjective in character; they are much more personal than the consciousness of environmental objects. Finally, our hypothetical introspector—that is to say, one who describes his own consciousness—is able to give us an account of his thinking activities. He may leave the store with his purchases, proceed to drive half-way home, and then suddenly recall his wife's instructions to buy paper plates. These plates, he will remember, are to be used on a picnic, planned for the following day; and he will debate "in his mind" whether he should drive on home, with the intention of buying them later in the day, or return at once to the store for them. This is the process of reasoning.

Of course the foregoing introspective report is actually a retrospective account. One cannot interrupt a train of thought for the purpose of observing it without interfering with the thinking itself. Hence we may assume that this account was

formulated after the actual mental events with which the introspection was concerned took place. For example, our introspector remembered *that he remembered* his wife's instructions. But as Titchener (11) points out, this fact does not vitiate introspective evidence. Doubtless an ex-service man to-day may recall the feelings and emotions which he experienced during the World War as vividly and as accurately as he recalls his objective experiences.

The Analysis and Description of Conscious Experiences. So far, we have discussed the kind of introspective analysis which the ordinary man, totally untrained in methods of psychological investigation, is quite capable of making. The patient who describes his internal aches and pains to his physician introspects in this way. Even so, patients differ considerably in their ability to introspect: where a keen observer, say a medical student, will describe his subjective symptoms with a fair degree of accuracy, an old-fashioned Negro mammy will complain of a "misery" in her side. Thus introspective ability is the product of intelligence and training.

One who has been trained in the introspective technique finds it easy to compare some of his conscious experiences and to classify them on the basis of their subjective resemblances and differences. Notice that specialists in fields other than psychology have developed similar abilities: the conductor of an orchestra is enabled to detect minute qualities and intensities of musical sounds by virtue of his musical training—his "mind" rather than his "ear" has been trained; and the expert chef makes fine gustatory discriminations as the result of his training. No mystery surrounds the introspective technique.

But psychological introspection differs from all other analyses of experiences. The psychologist who introspects at a symphony concert is prepared not only to analyze musical sounds but to observe his internal sensations as well. He is

interested in analyzing his feelings and emotions aroused by the music. Moreover, psychological introspection is not restricted to the description of sensory experiences. It is concerned, for one thing, with the analysis and description of mental images and ideas. For the psychologist who believes in consciousness, Watson's conclusion that thinking is the process of talking to oneself must be verified or rejected on the basis of introspective testimony.

As the result of data furnished by the introspective method, psychologists have described experiences known as sensation, perception, emotion, feeling, imagination, and reasoning. Many others could be added to this list. They have not stopped, however, at the analysis and classification of conscious *states,* for they have subjected conscious *activities* to introspective analyses. They have observed how consciousness changes during a period of time. Thus, our attention fluctuates from one object to another and from one idea to another during a period, say, of one minute.

Mental Activity. That mental activities are intimately related to physiological processes and overt behavior goes without saying. In fact, there could be no consciousness of any kind whatsoever without physiological activity taking place: certainly the body is active at all times when the mind is active. The behaviorists are not to be criticized for stressing this fact. It should be kept in mind that physiological activity includes brain activity.

Indeed, the majority of contemporary psychologists insist upon this dynamic or functional view of mind. As Woodworth (15) puts it, "Since psychology studies activities, its terms are properly verbs and adverbs." By way of explanation, he suggests that psychologists should substitute "remembering" for "memory," "thinking" for "thought," and "seeing," "hearing," etc., for "sensation."[1] Angell (2) not only thinks of consciousness as activity, but regards this activity as a form of

[1] *Op. cit.,* p. 5.

behavior. Angell expresses his view in the following language: "Broadly speaking, then, the psychologist's subject matter concerns thinking, feeling, and acting. When psychology is defined, as often occurs to-day, as the *science of behavior,* it is to be understood that the term behavior includes these three processes." [1]

Does Psychology Study Mind or Behavior?

Having outlined the respective views of the two major "schools" of psychology, we shall venture an opinion concerning their relative merits. It seems patent, as we have said, that they differ fundamentally regarding their theories of the *ultimate nature of mind.* They are primarily at variance, therefore, on a metaphysical issue. For centuries, philosophers have disagreed on the question of ultimate reality: some have argued that there are two kinds of reality in the universe, mind and matter, while others have claimed that either mind alone or matter alone makes up the universe.

If psychologists were obliged to answer this question before conducting experiments, they would give up in despair; but fortunately, *in practice,* most of them have ignored it. Some kind of inner, integrative activity is unambiguously manifested by the rat and by the human animal; perhaps it is indicated faintly by the behavior of the ameba. It is the psychologist's task to investigate this activity, not to discover its ultimate nature. The processes mentioned by Woodworth and by Angell actually occur in organisms, and as far as the present text is concerned, they are either mental processes or behavior activities, depending upon the arbitrary *point of departure* from which they are described. In other words, mental activities are so *intimately* related to certain physiological processes and to behavior that the same psychologist who studies "mind" on one occasion may study "behavior" on another, and yet be scientifically consistent. These considera-

[1] *Op. cit.,* p. 2.

tions justify the use of the word "psychologist's" rather than "psychologists'" in the title of this chapter.

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CHAPTER II

THE INTEGRATIVE PROCESS

The subject matter of psychology comprises the description and explanation of such phenomena as sensation and perception, memory, imagination and reasoning, intelligence, feeling and emotion, and learning; but underlying these is a general activity or process which we shall call the integrative process. To integrate means simply to organize parts into wholes; hence "integration," in the psychological sense of the term, implies the fact of organization in mental life and in behavior. As we explain subsequently in this chapter, the integrative process is variously described in terms of "association," "conditioning," "configuration," and "redintegration." "Integration" is merely a convenient generic term which designates the process without suggesting any theory concerning its nature.

An illustration will serve to explain further what is meant by the integrative process. A pianist reads the musical score, hears the selection as he plays it, and experiences certain kinesthetic and tactual stimulations furnished by the receptors of his arms and hands. Most of the stimuli which act upon his receptors, however, are not essential to his performance. In so far as they affect him at all, some help and some hinder his playing; hence he must *select* certain stimuli and *reject* others. As regards his overt behavior, his playing involves a series of coördinated movements. The elements of coördination include the direction, force, duration, and timing of his arm, hand, and finger movements. These are the elements which go to make up *skill.*

We have called attention to the sensory and motor elements

involved in the pianist's performance. The very fact that he plays the composition shows that he integrates or organizes these elements. The simplest explanation of his behavior holds that at any moment during his performance he is making a motor response to a sensory stimulation. As the result of years spent in learning to play the piano, he has developed connections or bonds between the printed musical notes, the pedals, and the keyboard, and the movements which constitute his actual playing. According to this hypothesis, he has also established connections between his arm and finger movements, and his foot movements, and the kinesthetic and tactual stimulations which are furnished automatically by these same movements. Broadly speaking, this type of explanation is known as *associationism;* in behavioristic psychology, it is formulated in terms of the *conditioned response principle.* Notice that theories which thus explain integrating activity as a connecting process must provide for both simultaneous and successive integrations of mental events and behavior units. At any one moment during his playing, the pianist is responding to a specific stimulus; but he has furthermore integrated a succession or sequence of stimulus-response units. Likely as not, he can whistle or hum the composition in the absence of the score and of the piano. In similar fashion, a person is capable of carrying on a succession or sequence of ideas. There are psychologists, however, who believe that integrating activity involves something over and above the establishing of connections between mental events which occur either simultaneously or successively. Thus, according to the Gestalt psychologists, the pianist has a mental grasp of the musical composition as a whole. Otherwise, in their opinion, he would be totally unable to play it. From this point of view, the pianist's mental grasp of the composition, or his configuration as we shall call it, is the important and essential psychological factor to be considered at any moment of his playing. Still other psychologists who cannot subscribe to

the Gestalt doctrine, are nevertheless in sympathy with its attitude toward mind. In general, it may be said that psychological explanations of the integrative process tend to stress either associational or conditioning processes, on the one hand, or some more general principle of mind, on the other.

Association and Its Laws

"By *association,*" says Robinson (15) in his recent treatise on the subject, "we may mean simply *the establishment of functional relations among psychological activities and states in the course of individual experience.*" [1] This definition is so comprehensive that we may use it as a point of departure for our discussion of associative principles. The expression, "psychological activities and states," provides for an exceedingly wide range of events. One kind of association presumably takes place below the level of consciousness. An earthworm may learn, after repeated trials in a laboratory experiment, to crawl towards food and to crawl away from a "painful" stimulus, such as sandpaper or an electrical shock, before it comes in actual contact with the food or with the irritating object respectively; this illustrates the phenomenon of "associative memory." In the human being, associations are formed between sensory and perceptual stimuli, and ideas, feelings, emotions, and motor responses. Thus one who returns to his childhood environment after years of absence from it may tend to recall his early experiences, to become sentimental over them, and to show forms of overt behavior which reflect his memories and feelings. All of these responses are associated with the perception of the familiar buildings and streets. The fact that ideas are associated with each other can be demonstrated by this same illustration: upon seeing his old high school building, he will recall one event after another which took place within its walls. A "functional relationship" implies that one

[1] *Op. cit.*, p. 7. The reader who is interested in a critical examination of associational psychology should consult this book.

associated activity or state is effective in "instigating" or arousing another mental or behavior event. Mental event *A* is functionally related to mental event *B* in so far as it elicits or arouses *B*. Finally, attention should be called to Robinson's emphasis upon association as the product of individual experience. Since all associations are acquired through experience, the term association does not properly refer to connections which are independent of personal experience. For instance, we need not invoke the principle of association to explain the peristaltic movements of the alimentary canal, or the sudden withdrawal of the hand when it is painfully stimulated.

As they were originally formulated, the *laws* of association grew out of an interest in "pure intellect"; some of them were formulated by Aristotle and later modified by the eighteenth century philosophers—that is to say, by men devoted to the study and the cultivation of the human mind. While the following account of these laws stresses their applicability to ideas, it should be kept in mind that the laws apply also to the various forms of association already mentioned.

It is well known that when we observe introspectively the passage of ideas which comes to us while reflecting or idly thinking, they seem to come in no systematic order. We may be walking along a country road and at the sight of a cow the idea comes to mind that it is a stupid-looking animal. This may be followed by the idea that our dog at home is much more alert than any animal we have ever seen. Then we recall that we forgot to tell the maid to let the dog out in the yard for his afternoon exercise. This idea in turn may remind us that we have certain Latin exercises to do when we get home. Upon which the thought comes to mind that our Latin teacher once told us he disliked dogs. Then the idle speculation as to whether dogs like Latin teachers flits through the mind, etc. In other words, we find one thought or idea giving way to the next in a more or less random fashion. Ever since the time of Aristotle, scholars have been interested in

this random, kaleidoscopic shift of ideas. Why does thought *A* give rise to thought *X* and not thought *Y*? Is there any cause and effect principle at work which determines the sequences of ideas? This is the problem of the association of ideas.

The Law of Contiguity. According to this law, whenever two experiences have occurred together, the subsequent return of one will tend to recall or reinstate the other. Hearing the word pipe makes us think of tobacco; Ellis Island makes us think of immigration; the word baseball induces us to think of bat, and so on. Since we have experienced these matters *together,* they become more or less united in our mind. Because of this "togetherness" or contiguity the law is referred to as the law of contiguity. This law, like all other scientific laws, summarizes an observed relationship. The matter is rendered somewhat more difficult by the fact that a given experience may be connected with a *diversity* of experiences. Under such circumstances we want to know which particular one of the many possible experiences will be revived on a later occasion. For example, the word pipe may be connected with tobacco as suggested, or with the idea of plumber, or with the word gas, or dream, or meerschaum, or briar, or lead, etc. Many contemporary psychologists regard *contiguity* as the fundamental law of association and explain the selection of one particular event from many which have been associated by contiguity in terms of certain *subordinate,* or *secondary* laws of association. These are the laws of frequency, recency, intensity, emotional congruity, and the mental set or the *Aufgabe.* We shall briefly consider them in order.

The Law of Frequency. The law of frequency states that if two or more events have been experienced together with a third one, and if on a subsequent occasion the latter is re-experienced, then, all other factors being constant, of all associates with that experience, the one that has occurred most *frequently* will more likely be reinstated than any other.

Warren (18) explains the principle of frequency as follows: "An experience which has been repeated many times tends to be suggested in form of a memory or thought more readily than an experience which has occurred in the past only once or a few times. We recall the name or looks of a friend much more readily than we recall a stranger. The same phenomenon appears in language; we recall and repeat far more readily phrases which we have memorized than those which we have read or listened to a few times only." [1]

Because of this factor of frequency of association, an habitual pipe-smoker upon hearing the word pipe is more likely to think of his own pipe than any other; or rather, than any one of the other possible associates of the word that we mentioned.

The Law of Recency. It may be, however, that if our hypothetical pipe-smoker just had a leak in his gas pipe repaired an hour before, his association will be different. If he should happen to be in a psychological laboratory and volunteer to act as a subject in an association experiment, then when the psychologist speaks the *stimulus word* "pipe," he may respond with the words "gas pipe" and not "my briar pipe." In other words the *recency* of the gas pipe experience gives it the advantage over the frequency of the other. Apart from other factors, this factor of recency enables us to recall more completely and more readily what we read in this morning's paper as opposed to what we read in last week's paper. Accordingly, we can formulate the *law of recency* to state that if two or more events have been experienced with a third one, and if on a subsequent occasion the latter is reëxperienced, then, all other factors being constant, of all the associates with that experience, the one that has occurred most *recently* will more likely be reinstated than any other.

The Law of Intensity or Vividness. Let us assume that last week's paper contained a picture of our father with a de-

[1] *Op. cit.*, p. 341.

tailed account of his appointment by the President to an ambassadorship. Under such circumstances, because of the intense and vivid nature of that experience, the stimulus word "newspaper" may evoke a memory of that experience rather than the sensational murder story which appeared in the morning paper. The factor of intensity will outweigh the factor of recency. Similarly, if ten years ago our habitual pipe-smoker lost his child as a result of axphyxiation due to a leak in the gas pipe, then the stimulus word "pipe" is apt to evoke the response "gas pipe," because of the intense nature of the tragedy connected with it. Here the factor of frequency is not strong enough to overcome the effect of the factor of *vividness* or intensity. Phenomena such as these are incorporated in the law of intensity or vividness. According to this law, if two or more events have been experienced together with a third one, and if on a subsequent occasion the latter is reëxperienced, then, all other factors being constant, of all the associates with that experience, the one that has occurred most *vividly* or most *intensely* will more likely be reinstated than any other.

The Laws of Emotional Congruity and Mental Set. The foregoing laws of frequency, recency, and intensity refer to the history of the associated experiences. In addition to such determining factors reaching back into the past, introspective analysis has revealed two others whose influence is more fleeting and momentary. One of these factors is concerned with the influence of emotions on our associations, while the other refers to the influence of definite intellectual problems or goals. The former factor is summed up in the law of emotional congruity and the latter is formulated in the law of mental set. We may take these up in order.

It is a familiar experience for most people when they are feeling depressed or "blue" to have most of their thoughts limited to matters that are depressing and discouraging. On the contrary, when in a happy or exalted frame of mind our

associated ideas tend to be pleasant, joyous, and encouraging. In fact, it is difficult to switch voluntarily the emotional trend of our ideas under the circumstances. The student who tries to refrain from giggling in chapel by endeavoring to think of "sad" things is an example of this. Another example is the difficulty we have of breaking up a train of worrisome associations by deliberately resolving to think only pleasant things. In other words, our emotional state at a particular instant of time acts as a directive factor in influencing the sequence of our associations. At the time of a quarrel with our best friend we find ourselves thinking only hateful thoughts about him. Similarly the lover when dominated by his emotion cannot associate unpleasant or unlovely things with the object of his affection. Consideration of such familiar facts as these has given rise to the *law of emotional congruity*. This law states that if two or more events have been experienced together with a third one, and if on a subsequent occasion the latter is reëxperienced, then, all other factors being constant, of all the associates with that experience, the one that is most in line with or most *congruous* with the emotional trend of the moment will more likely be reinstated than any other.

As has already been stated, the factor of mental set is similar to the factor of emotional congruity in that it is a present, rather than a past, controlling factor. A few examples will readily illustrate the sort of thing referred to by this factor. If we hear the digit seven spoken, and immediately after it the digit six, we might think of 76, 13, 42, etc., depending on whether we react to the stimulus words as calling for the reaction of perceiving a simple whole number, or the reaction of addition, multiplication, subtraction, etc. All these associates with the two numbers have been built up in the past and all are possible of re-arousal. However, if before the stimulus words are spoken we should hear the word "multiply," then only one response will take place and we shall be forced to think of "42." The instruction to multiply acts as

a controlling or directive factor determining the precise association that comes to mind. In the same way if we are asked to give the opposite of the word black, we think of white immediately, because of the directive influence of the instruction. Without such direction we might have thought of dog, Negro, yellow, a man by the name of Black, or any other experience we had at any time with the meaning conveyed by the word. The instructions given may be said to give a certain set to the mind, called a *mental set,* which determines the exact association that will be evoked by the stimulus words. Such associations as are guided along more or less predetermined channels or directed toward a definite end or goal are called *controlled associations.* Opposed to controlled associations are those which are more or less spontaneous and undirected, such as those that take place when we indulge in reverie or day-dreams. These are known as *free associations.* The words that come to mind when we are engaged in solving a cross-word puzzle illustrate the nature of such restriction. If we are searching for a four-letter word only short words tend to come to mind. Long, polysyllabic words are for the time being shunted off. In technical language we might say that the mental set facilitates responses in line with its goal and inhibits or wards off all others. Sometimes the German word *Aufgabe* is used to designate this mechanism of the mental set. This word means "task," "problem," or "assignment." The *Aufgabe* or mental set has to do with the particular task or problem governing the associations which come to mind. The assignment or *Aufgabe* is what makes the difference between free and controlled associations. We can thus formulate the *law of mental set* to state that if two or more events have been experienced together with a third one, and if on a subsequent occasion the latter is reëxperienced, then, all other factors being constant, of all the associates with that experience, the one that is most in line with the *Aufgabe* of the moment will more likely be reinstated than any other.

The Laws of Similarity and Contrast. Aristotle believed that contiguity, similarity, and contrast were fundamental conditions which govern the association of ideas. A number of contemporary psychologists agree with him to the extent of regarding *similarity* as a basic law. Witness Angell's (1) statement to this effect: "Few forms of association have attracted more attention, and perhaps none is more significant for human thought processes, than that of *resemblance,* or *similarity.*" According to this law, one mental event suggests a second one because the two present some point of similarity. "Doesn't Frank remind you of Howard?" is a familiar illustration of this law. The law of contrast is most frequently demonstrated in verbal associations. "Black-white," "up-down," "large-small" are examples. It is conceivable, as some writers contend, that we would never notice a similarity or a contrast between two items unless we originally experienced these items at the same time; hence it is theoretically possible to reduce the laws of similarity and contrast to the law of contiguity.

Inter-relationships Among the Laws of Association. As both Reed (14) and Robinson point out, psychologists are somewhat at variance regarding the relative importance of the different laws of association. Reed finds that mentalistic psychologists tend to distinguish between primary and secondary laws, and tend furthermore to regard either *contiguity* or *similarity* as the one primary law. On the other hand, the behaviorists, according to Reed, are inclined not only to disregard the distinction between primary and secondary laws but to attach more significance to some of the so-called secondary laws, *frequency* for example, than do their mentalistic colleagues. It should be said that such disagreements are serious because they represent fundamental differences in theories of integration.

Robinson reviews the situation in the following paragraph:

> Throughout the history of associational analysis there has been a recurrent search for the one essential condition of associative connec-

tion. For some writers the *sine qua non* has been contiguity, for others similarity has been the great associative *It*. Recently we have been witnessing a new manifestation of this same tendency. Much effort has been put forth, both in experimentation and in argument, to show that association is *not* brought about by *mere* frequency or by *mere* contiguity. What a shame it is that these writers have stopped there! They could so easily have gone on to show that association is not brought about by *mere* anything.[1]

Robinson concludes that the strength of any given association depends upon the particular *combination* of associative principles which is involved in the association. Thus, among other factors, interest, repetition, contiguity, recency, and understanding are all involved in the act of memorizing a poem. On one occasion, for a particular person, *repetition* may be the chief factor involved in the learning, while on another occasion, for the same or for another person, *recency* may account primarily for successful memorizing. But in each instance, several factors of varying degrees of importance are jointly responsible for the learning.

The Mechanism of Association. The various laws of association make an immediate appeal to common sense and the beginning student of psychology usually has no trouble in accepting them. That one idea should be associated with another seems perfectly obvious to him. In fact, for centuries the reality and utility of the principle of association was practically unquestioned. But with increasing knowledge regarding the part played by the brain in mental experience, difficulties in the way of accepting these laws at their face value began to present themselves. Very few, if any, psychologists to-day believe that ideas *as such,* or thoughts conceived of as separate entities, are ever associated. We may speak of them as associated only in the interests of descriptive convenience. The actual association—the real connection—takes place between the neural elements of the brain cortex. "The brain associates . . . ," writes Titchener (17), one of the leading ex-

[1] *Op. cit.,* p. 128.

ponents of the introspective method.[1] It is instructive to consider his treatment of what we have called the fundamental law of association. In this connection he says: ". . . let us call the brain-processes that are correlated with mental (conscious) processes 'psychoneural' processes. Then we may say: *When a number of psychoneural processes, all of which are reenforced and all of which stand alike under the directive influence of a nervous disposition, occur together under certain favorable conditions, then associative tendencies are established among them, such that the recurrence of any one tends to involve, according to circumstances, the recurrence of the others.*"[2] In a similar vein, Hunter (8) reminds his readers that when "we speak of a *function* of a conscious process it is only for convenience. It is the underlying nervous activity which has the function."[3] It is important to remember this fact of the neural basis of our conscious experiences.

The Principle of Conditioning

We now turn from the concept of association to a theory of integration which makes two fundamental assumptions, as follows: (1) all psychological phenomena can be classified either as stimuli or as responses; and (2) one stimulus can be substituted for another stimulus, and one response can be substituted for another response, under the general conditions which obtain when associations are established by *contiguity*. As regards its application to concrete behavior, the principle of conditioning is derived directly from the older principle of association by contiguity. On the other hand, as our discussion will show, the concept of conditioned reflexes originated in the laboratory of the Russian physiologist, Pavlov, a quarter of a century ago. Whether or not all "conditioned" responses are really conditioned reflexes is extremely doubtful.

First let us note some examples of behavior which establish

[1] *Op. cit.*, p. 149.
[2] *Ibid.*, pp. 164-165.
[3] *Op. cit.*, p. 297.

the fact of *substitution*. For purposes of convenience we may call some stimuli *original* and some responses *native*. Hunger is an original stimulus effective in producing the native response of crying. A bright light is an original stimulus which causes the eyes to move. Such stimulus-response relationships take effect without specialized training or experience. As is well known, however, both training and experience tend to modify these relationships. This modification is seen both on the response side and on the stimulus side. For example, a week-old baby will not respond with a movement of its lips when it *sees* the nursing bottle, but at the age of a year the same visual stimulus will cause a decided response of the mouth parts. The original stimulus that produced the mouth-opening response was *tactual* in character—bringing an object in contact with the lips; but now a *substitute stimulus,* the *sight* of an object, serves to bring about the same native response. In a similar fashion it can easily be shown how in the course of time the character of the native *responses* is changed. Objects originally grasped with the whole fist come to be grasped with the fingers alone. We may refer to such changes as *modified responses.*

In reality, every case of substitute stimulus may also be studied as a case of substitute response and vice versa. It is only a difference in emphasis and viewpoint which distinguishes them. A young colt will run if struck with a whip, but for the full-grown horse merely cracking the whip suffices to make him run. An auditory stimulus has been substituted for a cutaneous one. The youngster's mouth waters when he tastes a piece of chocolate. Later the sight of the candy, or even the sight of the printed word "chocolate," is adequate to bring about the same sort of salivary response. Here a visual stimulus has been substituted for a gustatory one. Another child is given a dose of castor oil mixed with orange juice. The mixture is so distasteful that the child struggles against

being made to swallow it; that is, it responds to the castor oil with avoiding movements. Before that time it always relished its orange juice. After this experience with the mixture of oil and orange juice, it responds to orange juice when given "straight" with avoiding movements or with a response of rejection. Here we have the response of avoidance originally attached to the castor oil stimulus also tied up with the orange juice stimulus. Again it is a case of one stimulus substituted for another. It is relatively easy to multiply these examples, but the ones given adequately illustrate the phenomena of substitution.

Pavlov's Conditioned Reflex Experiment. In the course of a comprehensive investigation of the part played by various glands in the process of digestion, Pavlov centered his attention on the functioning of the salivary glands. The original normal or adequate stimulus for the functioning of these glands seems to be the presence of food in the mouth. Food placed in the mouth of an animal increases the flow of saliva. Pavlov found that the smell or sight of food produces a similar effect. For the time being we may regard the taste, smell, or sight of food as adequate stimuli that normally elicit the salivary reflex. Any other stimulus, such as the sound of a bell, fails to influence the salivary mechanism. However, Pavlov found that if conditions are properly arranged such an auditory stimulus can be made to provoke a salivary reaction. This is consequently known as a *conditioned reaction;* that is, when by appropriate control of the conditions of stimulation, a stimulus originally inadequate to provoke a given reflex is rendered capable of doing so, we have a *conditioned reflex.* Under such circumstances the substituted stimulus is referred to as the *conditioned stimulus,* while the original or naturally effective stimulus is referred to as the unconditioned stimulus. For example, powdered meat placed in the mouth of a dog represents the unconditioned stimulus for the salivary reflex, while

the sound of a bell that subsequently brings about a similar reflex represents the conditioned stimulus.

The nature of the technique employed by Pavlov is illustrated and described in Figure 1. By referring to this figure, the student will see how the technique described enables the experimenter to measure the amount of saliva secreted during any period of time. Using apparatus of this sort, Pavlov measured the amount of saliva secreted by a dog when food is placed before it. He found that when a bell is sounded at a time when no food is before the animal, there is no measurable increase in the flow of saliva. If, however, the stimulating conditions are deliberately changed so that on repeated occasions when the dog is fed the bell sounds simultaneously with the feeding, sounding the bell alone will evoke the salivary reflex. A conditioned reaction to the sound of the bell will have been established. Assuming that the unconditioned response to the bell was merely a perking of the dog's ears, we can indicate the essential aspects of Pavlov's experiment in the following schematic way:

Before Training

Sounding Bell ——————→ Perking Ears
Feeding ——————→ Flow of Saliva

After Training

Sound of Bell ——————→ Flow of Saliva

According to the usual explanation of this phenomenon, the process of simultaneous stimulation establishes a connection between the brain center for hearing and the center that regulates the salivary secretion. It is further held that this conditioned connection, like the unconditioned one, is reflex in nature. This is another way of saying that it is a relatively simple neural connection between the auditory receptor and the salivary effector. Reflexes, it will be remembered, are native neural bonds between receptors and effectors, involving

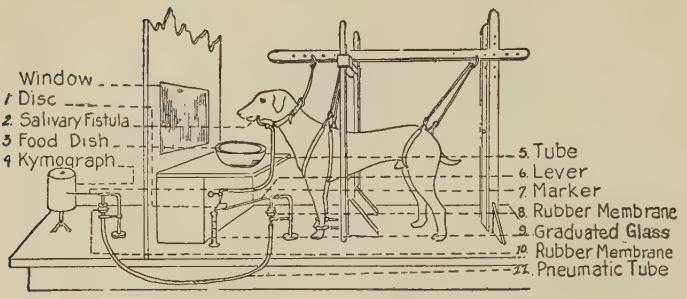

FIG. 1.—Diagram illustrating Pavlov's method of establishing the conditioned salivary reflex.[1]

The dog is presented with the unconditioned stimulus of the food in the small dish *3*. The food is introduced automatically through the window. Just prior to the presentation of the food the conditioned stimulus of the bell is started and usually continued through the feeding reaction. In order to secure an objective record of the flow of saliva an incision is made in the dog's cheek to the salivary gland. This is called a salivary fistula *2*. The opening of the fistula is connected with tube *5*. As the saliva trickles through this tube it falls on disc *1*. From the disc it drips into the graduated glass *9*. In this way the total quantity secreted can be measured. However, in striking the disc the drops of saliva depress lever *6*. This downward movement of the lever is transmitted to the rubber membrane *8* and as a consequence the air pressure in the pneumatic tube *11* is increased. As a result the rubber membrane *10* is made to bulge outward. This last movement causes marker *7* to move upward. A record of this movement is automatically made on the rotating smoked paper of the drum *4*. Such a recording device is called a kymograph. In this case the kymographic record tells the experimenter not only the number of drops of saliva secreted, but also the regularity of the flow. Additional markers are often employed to indicate the time or rapidity of secretion. It is also of interest to note that the harness works no hardship on the animals. After a little experience with the apparatus the dogs often become so conditioned to the experimental situation that they leap into the harness quite spontaneously as soon as they enter the room.

[1] Taken from Yerkes and Morgulis (21).

a receptor, afferent neuron, usually a central neuron, an efferent neuron and an effector. While we shall have occasion to criticize this explanation, it should be pointed out that it dispenses with the need for explaining the change in terms of "ideas" or other subjective factors. This pioneer experiment of Pavlov prepared the way for an objective, experimental approach to problems hitherto inaccessible to such treatment. It furnished psychologists with a new instrument and in many respects with a new point of view. However, before taking up some of the more distinctly psychological implications of the conditioned reflex principle, it will be profitable to consider in some detail a few of the characteristics of the conditioned reflex that have been revealed by studies on the part of Pavlov and his pupils.

Some Characteristics of Conditioned Responses. The amazing adaptability of the conditioned reflex technique is revealed in the number of investigations carried on in Pavlov's laboratory in Russia. Some of these have been summarized in English by Pavlov's pupil, Anrep (2). Unless otherwise stated, we shall be following this summary in our account of the work.

According to Anrep, "the method of conditioned reflexes is a method of experimental formation of new reflexes"; by "new" he means acquired as opposed to native or inborn. All reflexes acquired by an animal as a result of experience are to be regarded as conditioned reflexes. The conditions under which the animal lives determine the formation of these reflexes. Since this is the case the experimental work has to be carried on under particularly stringent control of conditions. All of the work is carried on in a sound-proof room. Furthermore, the animal is isolated from the experimenter who is in an adjacent room and who employs automatic devices during the entire course of the experiment. A periscope is used to observe the animal's behavior. In this way the possible influence of the presence of different people on the conditioning

process is eliminated and the experimental conditions are rendered relatively constant. All stimuli which might affect the animal save the ones actually being used in a given experiment are thus supposedly kept constant.

One fact revealed by this careful technique is the importance of controlling both the sequence and the duration of stimulation. With respect to the sequence there are three general possibilities:

(1) The unconditioned may precede the conditioned stimulus.

(2) The two stimuli may be presented *simultaneously*. The part played by duration of stimulation will be pointed out as each of these possibilities is discussed in order.

(3) The conditioned may precede the unconditioned stimulus.

There are three such combinations mentioned by Anrep:

(1) The unconditioned stimulus is applied first and then followed by the conditioning stimulus. This combination was carefully studied by Krestovnikov in 1920. He employed a tactile stimulus as the conditioning factor; that is, he first presented the unconditioned stimulus of the food and after a short interval of a few seconds he stimulated the dog's skin by scratching it. Although this precise combination and sequence of stimuli were presented over 1,000 times in the course of the experiment, Krestovnikov was unable to build up a conditioned reflex.

(2) The conditioning stimulus is given first and is instantly followed by the unconditioned, or else while it is still being applied the unconditioned stimulus is given. Such a combination calls for primary application of the conditioning stimulus (touching or scratching the skin) and then for the presentation of the unconditioned stimulus of the food. When this sequence is used, 20 to 30 trials will suffice to establish a conditioned reflex.

As some recent investigations show, however, we are not

justified in concluding that the conditioning stimulus necessarily precedes the unconditioned in order to establish a conditioned response. We shall revert to this point after concluding the discussion of Anrep's summary.

It has been found that varying the interval of time separating the *beginning* of the conditioned stimulus from the instant the food is presented makes for a definite variation in the final result. Considerable freedom may be exercised in the control of this time factor: the first stimulus may be applied from a few seconds to five minutes or more before the second. In any event, irrespective of the exact time interval, there is no actual pause between the cessation of the first and the application of the second. The two stimuli are made to operate *simultaneously* for at least a brief period in every trial. In other words, the first stimulus is not withdrawn until after the second has been introduced. Frequently it continues without a break throughout each trial and is even made to outlast slightly the second stimulus.

In connection with such variations of the time factor, it has been found that if a very short interval, such as a few seconds, separates the conditioned from the unconditioned stimulus during the training series, the resulting conditioned reflex will be characterized by a similar time interval. For example, the tactual stimulus is applied for three seconds; then the food is presented and after the salivary response to the food has been made, the tactual stimulus is withdrawn. With this time interval characterizing the trials, the conditioned reflex will not be evoked until three seconds after the application of the conditioning stimulus. If a two-second interval was maintained during the trials, the same interval will prevail after the conditioned reflex is established. Two seconds will have to elapse from the instant the tactual stimulus is applied until the saliva flows. In the same way, by appropriately controlling the time interval, it is possible to build

up a conditioned reaction that will not be elicited until the lapse of several minutes after the conditioned stimulus is given. Although there is no sharp line of distinction, in general, those reactions taking place after a very short interval are called simultaneous conditioned reactions, while those requiring a longer interval are called delayed conditioned reactions.[1]

(3) The conditioned stimulus is first applied and only after its withdrawal is the unconditioned stimulus introduced. This sequence of stimuli is the same as the foregoing combination with the exception that the unconditioned stimulus is not given until after the conditioned stimulus has ceased to act. There is always a gap between the two. Simultaneity of stimulation is not permitted to take place. Despite this fact, the conditioned reaction is readily established. However, since under the training conditions the food is not administered until after the tactual stimulus has been removed, "it is not the actual conditioned stimulus, but merely its trace left on the central nervous system, that is combined with the unconditioned one." The resulting conditioned reaction is consequently termed a *trace reflex*. In this type as in the previous type, the time of reaction is equal to the time intervening between the beginning of the conditioned and the onset of the unconditioned stimuli. According to Anrep, the longest time of reaction for trace reflexes that so far has been obtained is half an hour. This means that during the entire training period the tactual stimulus was first administered for a brief interval and then removed. After a delay of 30 minutes the dog received the food. By repeating this sufficiently often, a conditioned trace reflex was established. In this instance the *immediate* effect of applying the tactual stimulus was nil, but

[1] Anrep refers to these as simultaneous and delayed conditioned reflexes and actually uses the term, "latent period," in referring to the reaction times. Since such usage does violence to the usual meaning of the term reflex, it is better to refer to them as conditioned reactions.

after the expiration of thirty minutes the saliva flowed just as if food had been administered.[1] In trace reflexes it is not the duration of the conditioned stimulus that is significant, but rather the length of the pause separating the cessation of the latter from the application of the unconditioned stimulus.

These discoveries regarding the sensitivity of the nervous system to time intervals may be of importance in explaining many common problems. Among them we may note the regularity of digestive functions, the seeming ability of some people to control their hour of awakening by "making up their minds," and the changes in mood that often take place "for no reason whatsoever." In the latter case it may be that a conditioned stimulus experienced several hours earlier is responsible for the sudden emotional change.

Is Conditioning a Form of Association by Contiguity? In the light of evidence which has accumulated since Krestovnikov reported his findings, we are justified merely in concluding that conditioned responses are established more readily when the conditioning stimulus is applied first and the unconditioned stimulus afterwards than when this order is reversed. Switzer (16) succeeded in conditioning the human eyelid reflex to a sound, despite the fact that he gave the visual stimulus first and then applied the conditioned stimulus. The former was a hammer which struck a glass plate placed immediately in front of the subject's eyes. A time interval of ½ to 1 second between the applications of the two stimuli proved to be the most effective in establishing the conditioned response. Other investigators, including Pavlov, have ob-

[1] This interpretation may appear so exaggerated that the following statement of Anrep is given by way of justification:

"The longest latent period hitherto obtained was 30 minutes, with an accuracy of somewhat less than a minute." (*Op. cit.*, p. 407.) Anrep gives the dissertation of Feocritova (Petrograd, 1909) as the authority for the finding. This dissertation is summarized on page 376 of Morgulis's article previously mentioned.

served that conditioning can take place when the unconditioned stimulus precedes the conditioning or neutral stimulus.

In the opinion of many psychologists, conditioning can be explained in terms of contiguity, and the phenomena under discussion represent instances of forward and of backward association. Suppose, for example, that we blow a whistle within easy range of a dog's hearing, wait a second or two, and then give the animal its dinner. The neutral sound stimulus attracts and holds the dog's attention until the food is offered, whereupon it begins to eat. This neutral or conditioning stimulus becomes associated with the feeding behavior because it instigates a response which continues until the animal is fed. The first response is the physiological (or possibly the mental) condition of "attention," and the second comprises the activities involved in seizing and swallowing the food: the two stimulus-response processes become associated because they actually overlap in time, even though the sound stimulus ceases before the food stimulus is presented. On a subsequent occasion, the auditory stimulus serves as a *sign* or *signal* that food will be forthcoming; in other words, the animal has been conditioned to expect food when it hears the whistle. But suppose that we feed the dog first and then blow the whistle; in this instance, there is no reason why the sound and the feeding response should become associated. Although the dog is now digesting its food, the food *stimulus,* in the exteroceptive sense of the term stimulus, belongs to the past. Unless we administer the sound stimulus before or during the eating period, the chances are that it will not tie up with the feeding response.

This analysis of conditioning in terms of association by contiguity explains Krestovnikov's results, and in the absence of factual evidence to the contrary, it would tend to prove that associations cannot be established in a backward direction. We have seen, however, that they can be so established. Switzer evoked the eyelid response before he gave the signal

for this response—that is to say, before he administered a stimulus that could become connected with the response. Evidently, however, the effects of the visual stimulus which he employed persevered until the auditory stimulus was used; the two responses overlapped to a certain extent. Associations formed in either a backward or a forward direction are thus thought to be forms of *simultaneous* association. The psychologist Guthrie accepts this theory and formulates one principle which combines the principle of conditioning and the law of association by contiguity. In Guthrie's (6) language, ". . . stimuli acting at a given instant tend to acquire some effectiveness toward the eliciting of concurrent responses, and this effectiveness tends to last indefinitely."

The Conditioned Reflex in Animal Psychology. The conditioned reflex method is particularly important in animal psychology. By means of it the psychologist can secure an understanding of certain phases of animal mentality which have hitherto been incapable of direct solution. A good illustration of this matter is to be found in the study of the dog's auditory sensitivity. As far as humans are concerned, this problem has been approached by asking the subject to indicate whether or not he can hear a particular sound under given conditions of stimulation. It is obvious that such an approach is impossible in the case of the dog. As a consequence, it was only by conjecture that the animal psychologist could say whether an animal was able to hear a given sound. To-day he can settle the question by means of the conditioned reflex technique.

In order to do this it is necessary to establish what is known as the *differential conditioned reaction.* The dog is first made to respond to a given auditory stimulus with a flow of saliva according to the regular conditioning procedure. A different sound is then introduced and if the flow takes place as before, it is assumed that the animal fails to perceive the difference. The sound is varied until the animal fails to respond to the

variable sound while still responding to the original conditioned stimulus. In other words, a differentiation between the two sounds has been revealed. By this method of differential conditioning, it has been shown that the dog's hearing is more sensitive than man's. According to Morgulis (13), a tuning fork of 1,012 vibrations is distinguished from one of 1,000 vibrations. A metronome beating at the rate of 100 strokes is reacted to, while one of 94 is not. It has also been demonstrated that the dog will not only perceive a difference as small as one-eighth of a tone, but that he can also perceive tones that are inaudible to humans.[1]

The Conditioned Reflex in Human Psychology. Experimental investigations carried on both in this country and abroad have shown that the conditioned reflex method with the advantages of its objectivity can be used for solving problems of human as well as animal psychology. Substitute stimuli have been successfully introduced for glandular responses, for striped muscle reactions, and for smooth muscle reactions. In other words, all types of effectors are susceptible of having their afferent connections modified. Without any attempt to give a complete account of these experiments,[2] we may well turn our attention to a few of the more outstanding ones which help explain the general subject of substitute stimulation in humans.

The Conditioned Salivary Secretion in Humans. As an example of the establishment of conditioned salivary reactions in human subjects we may cite the work of Lashley (11). Of course in the case of humans it is impossible to make an incision to connect the measuring tube with the salivary gland. Lashley circumvented this difficulty by constructing a piece of apparatus which could be placed in the subject's mouth for

[1] *Op. cit.*, p. 144.

[2] For a very readable and semi-popular account of the significance of conditioned reflexes in human psychology together with an excellent and simple summary of the chief experimental researches, the reader is referred to the text by Burnham (3).

the purpose of collecting drops of saliva and conducting them out of the mouth. In this way the amount of saliva normally secreted and the amounts secreted under stimulating conditions could be measured. Burnham cites the following results secured by Lashley in his experiment with a child:[1]

Normal rate: about one drop per minute.

Chocolate placed in subject's hand:	
1st minute	4 drops
2nd minute	3 drops
3rd minute	4 drops
Subject smelled chocolate	5 drops
Brought chocolate to lips but kept mouth closed	9 drops

The increased flow of saliva resulting from the contact of the chocolate with the subject's hand is in some respects comparable with results Anrep secured in his tactual conditioned reflexes in dogs. Our earlier example of the child who came to dislike orange juice because "it tasted like castor oil" is seen to be a case of conditioning similar to the above instance of having the child smell the chocolate. In both cases we have olfactory conditioned reactions.

Watson (19), referring to this experiment of Lashley, makes the following statement: "Unless this method had been employed, we would not have known that the mere sight and touch of food had such a stimulating effect. The subject's own report is worthless, because the food might have inhibited swallowing, even though the fluid came at a normal rate. He probably would have told us that his mouth watered. Some situations as we have experimentally determined do actually inhibit swallowing; then the mouth fills with fluid, even though the stimulus actually produces glandular inhibition. . . . It is quite possible that all the glands of the body are subject to stimulus substitution."[2]

The Conditioned Motor Reflex in Humans (Striped

[1] *Op. cit.*, p. 88.
[2] *Op. cit.*, pp. 31-32.

Muscles). Conditioned motor reflexes involving the striped muscles have been established in humans by several physiologists and psychologists. Krasnogorski [1] succeeded in applying the conditioned reflex technique to infants less than a year old and to very young children. He selected the reflex of opening the mouth as the response to be conditioned. After quieting the youngster to be experimented upon, the child was blindfolded and the spontaneous movements of the mouth and throat were recorded for purposes of securing a control record. When the child was given a taste of a bit of candy (unconditioned stimulus) a bell was sounded. After a few repetitions of this combination of stimuli, sounding the bell alone brought about an opening of the mouth. This was a conditioned auditory motor reflex. In the course of his work Krasnogorski also established tactile conditioned motor reactions, differential reactions, and trace reflexes. It is evident that the various kinds of conditioned reactions secured in animals can also be established in humans. This pioneer application of the conditioned reflex technique to humans was modified and improved by the American psychologist Mateer (12). She found that the speed with which conditioned reflexes can be established in children may be developed as a means of measuring intelligence. Feeble-minded children are not conditioned as readily as youngsters with normal mental endowment.

Conditioned motor reactions for the muscles of the fingers, analogous to the flexion reflex in the case of the dog, were obtained by Watson,[2] Hamel (7), and others. Another striped muscle mechanism that psychologists have succeeded in conditioning is the winking of the eye. This was accomplished by Cason (4). As is well known, winking can take place both voluntarily and involuntarily. Cason not only succeeded in provoking the wink reflex by a substitute stimulus, but he was also successful in making the resulting conditioned reaction

[1] Burnham, *op. cit.*, pp. 92-97.
[2] *Op. cit.*, p. 33.

take place more quickly than the voluntary wink response. Such a result means that the mechanism of the conditioned reaction is very likely different from the mechanism by means of which the same reaction is brought about voluntarily.

The Conditioned Motor Reflex in Humans (Unstriped Muscles). In another experiment, Cason (5) showed that unstriped muscle tissue can be acted on by indifferent stimuli as a result of conditioning. He selected the pupillary or iris reflex as the mechanism for investigation. The fundamental or adequate or unconditioned stimulus provoking this reflex is a change in the intensity of the light striking the eye. When a brilliant light is flashed into the eye, the smooth muscle fibers located in the colored part of the eye (the iris) contract and the pupil becomes smaller. On the contrary, when the conditions of illumination are poor, as in dim light, certain radial muscle fibers in the iris contract and the pupil is dilated. In other words, the unconditioned responses characterizing the iris reflex are as follows:

Stimulus of Bright Light ⟶ Response of Pupillary Contraction

Stimulus of Dim Light ⟶ Response of Pupillary Dilatation

In his experiment, Cason tried to condition these pupillary responses to a sound stimulus, the sound of an electric bell. In a preliminary experiment, however, he found that his proposed substitute stimulus without training caused a slight dilatation of the pupil.[1] He also found that in order to obtain the best results from the conditioning process, it was necessary to give the auditory stimulus *while* the pupil was changing in size.

In the endeavor to bring about a conditioned contraction, Cason increased the intensity of light being flashed into his subject's eye. At the same time the bell was sounded. After

[1] *Op. cit.*, p. 110.

approximately 400 repetitions of this combination of increase in light intensity plus the bell, the conditioned reaction was set up. Now, sounding the bell alone caused a contraction of the pupil. This was a clear-cut case of conditioning, since the original effect of the bell on the pupil was to cause a slight dilatation. In other words, the effect of the simultaneous stimulation was not only to bring about a substitution, but even to reverse a preëxisting response.

However, in those experiments designed to make for conditioned dilatation, his results were not quite so clear-cut. Cason himself evidently interprets his results as showing the establishment of conditioned dilatation; but his data are not altogether convincing. In conditioning for dilatation, the bell was sounded along with a decrease in light intensity. In order to establish an unmistakable conditioned reaction, the final response to the bell alone should show a dilatation greater than that taking place normally upon sounding the bell. Cason does not make this claim, but he concludes nevertheless that a conditioned dilatation was established, for after the training, the combined stimuli of the sound and the decrease in light intensity resulted in a greater dilatation than the combined stimuli had produced in the beginning. To interpret such a result as a conditioned reflex is to distort the meaning of the term. It is better interpreted as an example of facilitation or reënforcement. At all events, though, Cason has certainly shown in the case of the pupillary contraction that substitute stimuli may be connected with smooth muscle mechanisms in accordance with the requirements of the conditioned reflex concept. In the case of the pupillary dilatation he has at least demonstrated the influence of co-acting exteroceptive stimuli on the functioning of involuntary or smooth muscles.

Conditioned Emotional Reactions. An important theoretical and practical application of the conditioned reflex principle is seen in the modern method of studying the genesis of our likes and dislikes. Traditionally, such affective or feel-

ing reactions have been accounted for either on the basis of reason in those cases where the individual was able to state definitely why he liked or disliked certain things or people, or else they have been explained on the basis of ideational association. When neither of these principles could be applied to the particular affective reaction, it was accounted for on the basis of inheritance. Watson paved the way for a new line of approach to this question by employing the genetic method. He conducted his investigations in a maternity hospital and used as his subjects infants whose entire emotional history was known. They were from 170 to 200 days old. He found that such stimuli as cats, rabbits, and a pigeon in a paper bag failed to evoke fear responses either when the babies saw them or touched them. Similarly, a baby held by a stranger in a faintly illuminated room showed no fear when a dog jumped upon the couch near it. A barking dog at the end of a leash and various animals seen at the zoo likewise proved ineffective as fear stimuli. All these frequently-assumed "native fear stimuli" gave negative results.[1]

Before giving a summary of Watson's results, it might be well to point out some of the implications of the problem under consideration. Before we can indicate the actual development of our emotional reactions to various situations, it is necessary to determine the original stimuli which evoke emotional reactions. Any stimulus resulting in an emotional response may be spoken of as an emotional stimulus. The term emotional stimuli refers to any source of exteroceptive excitation that is the immediate antecedent of an emotional reaction. For the present, we may disregard the possibility that emotions are either modified or initiated by such internal stimuli as endocrine secretions or other metabolic factors. In this discussion we are limiting ourselves to the exteroceptive phases of stimulation. Accordingly, the burglar who terrifies his victim, the infant that elicits love from its mother, and

[1] *Op. cit.*, Chapter VI.

the crawling insect that fills some sensitive individual with disgust represent the stimulus aspects of these situations.

Such examples of emotional stimuli and reactions are readily found. The question that confronts us in each case is the problem of deciding whether the particular emotional stimulus represents the unconditioned stimulus for that emotional response, or whether something akin to a conditioned stimulus is responsible for the emotional display. The possibility of conditioned emotional reactions is a relatively recent conception.

Emotional responses to specific stimuli were formerly explained in terms of heredity. For instance, both the color red and the smell of blood were supposed to excite cattle to anger. Tradition also claims that animals have hereditary enemies. Cats, it is said, inherit a fear of dogs; and birds, in turn, inherit a fear of cats. Furthermore, particularly intense emotional experiences are presumed to leave such an indelible impression on the animal or human organism that the effect of the experience is passed on to the succeeding generations of the species. Such an explanation is, of course, based on the now practically discarded theory of the inheritance of acquired characteristics.[1] In the older psychological literature the inheritance of the vestiges of ancestral experience, accepted as a fact, was frequently used to explain many cases of emotional reaction. We find, for example, that even so astute a psychologist as James explains the fright of a puppy thrown into a panic by a fur rug in terms of the emotional experiences of its ancestors. Similarly, human beings are supposed to fear darkness, blood, water, confinement, wild animals, and other natural objects and situations because of vestigial ancestral experiences. A case in point is the familiar explanation that our

[1] For an excellent summary of the present status of this theory with particular reference to Pavlov's contention that conditioned reflexes are inherited see T. H. Morgan's article entitled "Are Acquired Characters Inherited?" It is to be found in *The Yale Review* for July, 1924, pp. 712-730.

dreams of falling through space reflect the arboreal habits of our pre-human ancestors. Such an explanation is often given in all seriousness and by way of confirmation it is further alleged that since our actual line ancestors were evidently not killed by falls, we consequently never dream of being killed in this way. According to such theories, not only our fears but our loves hark back to prehistoric times.

Watson's Experiments with Infants. We are now in a position to resume our account of Watson's investigation of the emotional responses of infants. As has already been stated, he got negative results when he confronted the babies with a variety of stimuli that are frequently alleged to be "naturally" fearsome. Some of the animals belonged to species that are often classed as man's "natural" enemies. Accordingly, if there is any basis in fact for the common theory of the inheritance of the traces of our ancestors' oft-repeated emotional experiences, Watson's tests should have resulted in some definite emotional responses. Since he failed to secure them, his experiment certainly lends no support to the idea of the existence of vestigial traces in the infants' brains.

In all instances where emotional responses were elicited from infants, Watson found that the stimuli were distinctly physiological. They were explicable in terms of direct sensorimotor connections, rather than ancestral memories. For example, he found that the situations evoking fear were the sudden removal of support, loud sounds, a push or a shake, or a sudden pull on the blanket on which the infant was sleeping. Watson found no evidence in support of the belief that infants are instinctively afraid of the dark. In the case of anger or rage he found that the one adequate stimulus consisted of hampering the infant's movements. A response which Watson designates as love was called out by tickling, patting, and stroking parts of the body, and by rocking or dandling the infant. Since these three emotions of fear, rage, and love were the only forms found by Watson in young infants, we may

assume that his list of adequate unconditioned emotional stimuli is fairly complete, although future experiments may necessitate minor revisions.

Watson's results lead to the conclusion that the majority of emotional responses made by children and adults were originally conditioned by experience. In terms of the conditioned reflex principle, almost any stimulus presented concurrently with one of the adequate physiological stimuli a sufficient number of times should, of course, itself become effective in eliciting the same emotional response. In order to test this hypothesis, Watson selected an eleven-months-old infant that had displayed no fear of a white rat and subjected this infant to the combined stimuli of the rat and sudden noise. As was expected, the infant subsequently showed marked fear when the rat alone was presented. Moreover, further experimentation showed that this fear was transferred to a rabbit, a fur coat and, with less intensity, to a dog and to cotton wool.[1] We might note incidentally that while this experiment was somewhat detrimental to the infant's emotional welfare, it is exceedingly mild as compared with the treatment frequently accorded infants by mothers and nurses.

The Unconditioning of Emotional Reactions. According to modern psychiatrists, mental disturbance is more a matter of distorted emotional life than of illogical or irrational thinking. Control of emotional reactions is thus of great importance in the preservation of mental health and the attainment of personal efficiency.

Watson's experiments have demonstrated the vast majority of our specific attitudes of aversion, hostility, and affection to be the result of conditioning experiences. This is particularly the case in infants and children where presumably emotional conditioning occurs so readily.

Unfortunately, however, unfavorable conditioning cannot

[1] This possibly accounts for the fear of the rug manifested by James's puppy.

always be avoided. In daily life it is well-nigh impossible to shield the infant from all conditioning circumstances. While the baby is out for an airing, a dog may bark suddenly and loudly. The auditory stimulus provokes a fear reaction and since the visual stimulus of the dog is simultaneously experienced, the sight of a dog may thereafter suffice to make the child afraid. It may now be said to be conditioned against dogs. Is it possible to detach or uncondition such a fear?

The experiments of Jones (9) were concerned with this problem. In connection with a study of children's fears, this investigator developed a technique whereby negative, avoiding reactions of fear were replaced by positive, approaching reactions. Her method was to confront the child with the fear-object during its meal. She first determined how far the fear-object had to be removed before the child would eat. This distance gave a rough measure of the initial strength of fear. While the child was eating, the object was brought close until it produced an avoiding response. This procedure was continued on successive days until the object could be brought directly up to the child. This method depends for its effectiveness on the strength of the child's hunger. By way of illustrating the method concretely, Jones cites the case of Peter, a boy of 2 years, 10 months, who was one of her most difficult cases. Two months of daily or twice daily treatment were required before his particular fear was eliminated. The following laboratory notes describing the first and last days of experimentation serve to summarize the method and indicate its effectiveness:

March 10, 10:15 A.M. Peter sitting in high chair, eating candy. Experimenter entered room with a rabbit in an open meshed wire cage. The rabbit was placed on the table four feet from Peter who immediately began to cry, insisting that the rabbit be taken away. Continued crying until the rabbit was put down 20 feet away. He then started again on the candy, but continued to fuss, "I want you to put Bunny outside." After three minutes he once more burst into tears; the rabbit was removed.

April 29, 9:55 A.M. Peter standing in high chair, looking out of the window. He inquired, "Where is the rabbit?" The rabbit was put down on the chair at Peter's feet. Peter patted him, tried to pick him up, but finding the rabbit too heavy asked the experimenter to help in lifting him to the window sill, where he played with him for several minutes.[1]

As Jones points out, this method must be delicately handled. "Two response systems are being dealt with: food leading to a positive reaction, and fear-object leading to a negative reaction. The desired conditioning should result in transforming the fear-object into a source of positive response (substitute stimulus). But a careless manipulator could readily produce the reverse result, attaching a fear reaction to the sight of food." [2]

Does Conditioning Explain Behavior? Inasmuch as the principle of conditioning purports to explain both human and animal behavior, its scientific validity can be tested by its applicability to the behavior of any organism.

Let us examine it with reference to human behavior. Not only Watson, but F. H. Allport, Smith and Guthrie, and other psychologists apparently find in the principle of conditioning a satisfactory explanation of all human behavior. Advisedly or not, psychologists who accept this principle at all tend to apply it universally to human social activities.

Numerous facts derived from everyday observation apparently confirm their conclusion. The burnt child dreads the fire because his hand-withdrawal response becomes conditioned upon the visual-thermal stimulus. The human adult who resolutely decides to quit smoking finds that even the printed reference to the habit, especially when it is embodied in an alluring novel or short story, strongly tempts him to indulge once more. His responses are so thoroughly conditioned upon verbal stimuli that the actual perception of some one's

[1] *Op. cit.*, p. 389.
[2] *Ibid.*, p. 389.

smoking may tempt him less than do the printed words. Watson describes an imaginary psychopathic dog to show that the psychopathic human is merely the victim of anti-social conditioning. This dog, among other things, eats decayed food in preference to fresh hamburg steak and sleeps in an ash can when a comfortable bed is available.

Conditioning seems to be disclosed in the most socialized forms of human response. A student acquires a general distaste for history because he dislikes some instructor in this field. Upon realizing that her fiancé likes olives, a girl may suddenly discover her own fondness for this food. Superficially, at least, such instances are comparable with the examples of infantile conditioning described by Watson, and with the behavior of Pavlov's dog.

Now it is sufficiently obvious that the principle of conditioning presupposes the stimulus-response formula for envisaging behavior. It assumes, in other words, that the unit of behavior is the response made by the organism to a stimulus. But this formula stands in need of interpretation: whether it is adequate or inadequate depends upon the way it is applied. Does it, for example, provide for the fact that human behavior is determined largely by motives, ideals and attitudes, likes and dislikes, and ambitions? If the stimulus-response formula, and consequently the principle of conditioning, are to be applied to human behavior, they must be sufficiently elastic to provide for such factors in human psychology as those just mentioned.

As we have seen, Watson, Kuo, and certain other psychologists dispose of this troublesome question by reducing all motives to forms of interoceptive stimulation and visceral tension. According to this view, the desire to be complimented or praised can be classified as an internal, interoceptive stimulus, originating in the visceral systems of the body. Thus stimulus-response, conditioning, and mechanistic psychology are closely related.

It follows that the principle of conditioning must be interpreted in one of two ways. If it is made sufficiently elastic to include all human ideas, ideals, and motives, it automatically reduces some of the important factors in human conduct to stimuli or to responses. Many psychologists, however, insist that such factors *intervene* between the stimulus and the response. They point to the fact, mentioned in the previous chapter, that frequently and perhaps typically the organism *seeks* the stimulus. If, on the other hand, conditioning merely implies that one external stimulus may be substituted for another, or that a response made to an external stimulus may be replaced by another response to the same stimulus, then *the principle of conditioning literally describes only one of the conditions under which learning, or any other form of modified behavior, takes place.* Whether or not it calls attention to the most important of these conditions is a debatable question.

Gestalt Psychology and the Integrative Process

Gestalt psychology originated in Germany some twenty years ago. "Gestalt" is the German word for "pattern" or "configuration." Various aspects of Gestalt or of configurational psychology are discussed in other chapters of this book; as regards the present chapter, interest centers upon the explanation of the integrative process offered by sponsors of this standpoint.

Configurational psychologists are emphatic in contending that neither the principle of conditioning nor the laws of association explain psychological activities. In fact, they reject the concept of integration, as this concept is ordinarily employed, and substitute for it the view that mental events are organized wholes. The organism does not integrate ideas or behavior units in the sense of associating ideas or associating stimuli with responses; rather, it is aware of certain relationships of some kind between objects the moment it sees the objects, and consequently it reacts to these objects intelli-

gently. All mental events, according to this hypothesis, are related in so far as they are experienced at all, and the mental events *as related* are the patterns or configurations with which Gestalt psychology is concerned.

Let us revert to the illustration used in the introductory section of this chapter. Gestalt psychologists hold that the human being, in listening to music, always reacts to *relationships* among musical notes. That is to say, he reacts to patterns, or configurations, in combinations and sequences of notes, and not to the individual notes as such. They urge that the musical response remains substantially unaltered when the composition is transposed from one key to another. As regards rhythm, the listener responds to pauses as well as to auditory stimuli; in other words, he responds positively to periods of no auditory stimulation. The musical response, then, made by the most unmusical person in the world, is thus an immediate mental reaction which cannot be explained in terms of the association hypothesis.

Both Köhler (10), one of the original leaders of the Gestalt movement, and Wheeler (20), an American psychologist who actively supports this movement, attempt to show that the laws of association cannot explain simple instances of verbal memorizing. To illustrate, it is the customary procedure in psychological investigations of memorizing to substitute nonsense syllables for words, on the assumption that nonsense syllables are relatively devoid of meanings. "Gub," "tej," "soh," and "giq" are examples of nonsense syllables. Such investigations, therefore, purport to disclose the mental operations involved in the act of memorizing where the factor of meaning is eliminated or reduced to a minimum. Now many psychologists assume that the laws of association explain this kind of verbal memorizing. The subject learns a series, say, of 20 nonsense syllables by associating them according to the principles of contiguity, frequency, repetition, vividness, etc. Thus, he supposedly learns them by *contiguity* and by *fre-*

quency when they are given to him in pairs: he is then instructed to write the second member of each pair when the first member only is presented to him. And of course, *contiguity* is also involved when the 20 syllables are given to him in serial order, for No. 1 is associated by contiguity with No. 2 in the series, No. 2 with No. 3, and as compared with the syllables at the end of the series, No. 1 with No. 3.

But Köhler argues that when a subject reads syllables in order to memorize them, he invariably groups them into units, and perhaps sings them to himself. Then, on being presented in a different order, according to Köhler, the same syllables appear to be new or strange to the subject. On the basis of this evidence, Köhler concludes that the subject organizes the syllables *during* the learning into some kind of a pattern or scheme.

The four examples of nonsense syllables given above are the first four in a list of 10 furnished by Wheeler, together with a list of 10 unrelated words ("cow," "sun," "fir," etc.) and a third list of 10 related words ("room," "floor," "wall," etc.). Wheeler's subject required 12 repetitions to memorize the nonsense syllables, four repetitions to memorize the unrelated words, and one repetition to memorize the list of related words. In explanation of the subject's memorizing process, Wheeler makes this statement: "He learned the first list almost mechanically, by rote. It was not sheer repetition, however, which enabled him to memorize it; he learned each syllable in its *spatial relationships* to other syllables in the series, especially to those adjacent to it. These spatial relationships were important factors of insight, limited though the latter was."[1]

Of course, memorizing is only one kind of learning. Viewing the learning process as a whole, Wheeler finds that organisms do not learn by experience in the sense that experience is a *sum* of past impressions. When the child touches the

[1] *Op. cit.*, pp. 245-246.

candle flame for the first time, he has a new and an immediate experience; during this painful and crucial moment, he learns that the flame is hot; and consequently, he may never touch it again. In general, according to Wheeler, no organism profits by past experience unless it has sufficient insight into the experience to profit by it. Mere contiguity or conditioning does not suffice.

The key-word in this type of explanation is *insight;* but what is insight? The behaviorist would contend that the child becomes negatively conditioned to the candle flame during the brief moment when he is touching it. As we explained in Chapter I, insight and its companion term foresight are both *visual* terms. They refer to the capacity of the organism to see objects at a distance and to prepare itself for an encounter with them. The dog will approach its master even though it has once been whipped by him; it will not necessarily avoid the whip so long as this instrument is lying on the floor; but it will cringe upon seeing, for the second time, the master *with* the whip. According to Gestalt psychology, this response indicates a *perception of relationships,* and according to the conditioned response hypothesis, it indicates conditioning upon the object, master-with-whip. Are the two interpretations incompatible?

Let us now consider the hypothetical case of a man who is attempting to find his way at night through a forest. Since, we will assume, his destination is toward the north, he deliberately and consciously follows the direction indicated by the north star. In so doing, as the behaviorists would explain his progress, he is reacting to a persisting visual stimulus for a relatively long period of time. In addition, he is following a trail which almost disappears at times—a persisting but a fluctuating visual stimulus. Also, while this is going on, he is reacting to the numerous trees and bushes which impede his progress. He is furthermore responding to such general physiological factors as his condition of fatigue and of health and

his emotional condition, in so far as emotion is physiological "commotion." All of these factors, of course, represent years of previous conditioning.

Notice that this description is valid in the sense that it represents *one* legitimate way of describing a behavior act. Like any other psychologist, the behaviorist uses a system of explanatory terms or concepts. This night traveler does respond to temporary and to persisting visual stimuli, and his behavior is controlled by various physiological factors which function within him and which constitute part of his reacting mechanisms.

Now, as we have implied, Gestalt psychologists are vigorously opposed to anything resembling *atomism*. Any kind of psychology is atomistic in so far as it attempts to construct larger units by combining smaller, indivisible units. Behaviorism would be atomistic if it attempted to combine reflexes, or to combine reflexes and instincts, or to combine reflexes, instincts and habits, in order to account for the concrete activities of men and of animals.

It is only fair to point out, however, that intrinsically and logically, behaviorism is no more atomistic than any other kind of psychology. Most behaviorists would acknowledge that in all instances a stimulus-response relationship is abstracted from the total behavior of the responding organisms. It never furnishes a complete account of what the organism is doing at the time. In other words, *the stimulus-response act is the unit of behavior because it is the unit of the behavior analysis made by the psychologist who studies the behavior.* In a sense, therefore, all stimulus-response units are artificial responses.

Consequently, Gestalt psychologists correctly assume that no aggregate of separate and distinct conditioned responses could possibly explain the behavior of the traveler. Certainly the normal human being relates and organizes his experiences and his responses, not by the process of simple addition, but

by some integrative principle which has not, as yet, been *completely* explained by the principle of conditioning or by mechanical associationism. In the absence of more adequate explanatory concepts, Gestalt psychologists seem justified in employing "insight" to designate one phase of this integrative process, but they are scarcely justified in discarding the concept of integration, and the principles of association and of conditioning.

Redintegration

Hollingworth explains integration in terms of *redintegration.* As he uses the term, "to redintegrate" means "to restore." The redintegrative principle is expressed in the statement that after a complex stimulus has once elicited a response, any part of this stimulus which subsequently acts upon the organism ". . . provokes the complete reaction that was previously made to the complex stimulus as a whole."

To borrow one of Hollingworth's illustrations, a child who has been frightened by a growling dog tends to show the original fear response *in toto* when he hears another dog growl, or when he hears his father imitate a growling dog. The sound alone suffices to evoke the response originally made to the entire, concrete situation.[1]

This illustrates both the general principle of redintegration and one of its sub-laws. Hollingworth calls the sub-law the principle of *partiality* because, in instances such as the one just described, the part represents the whole. At times, however, some incidental stimulus which affected the organism when it responded to a complex situation may, upon affecting the organism again, evoke the original response. This is the principle of *concurrence,* which is Hollingworth's term for conditioning. If the child happened to be eating an apple when it was frightened, the mere sight or smell of an apple on a

[1] Hollingworth's quotation and his illustration are taken from *Psychology: the Science of Mental Activity,* by Frederick H. Lund. A. G. Seiler, 1927.

later occasion would tend to evoke the response. Finally, a stimulus may be reduced in intensity without losing its original potency; here we have the principle of *reduction.* A very faint growl may arouse the fear response in its original intensity. But in all three instances, ". . . a partial feature is seen to function as the surrogate for a more elaborate antecedent context," etc.[1]

In many respects, the concept of integration is broader or more comprehensive than the principles of integrative activity discussed previously in this chapter. Hollingworth claims that where association by contiguity and conditioning merely state the objective conditions under which integration occurs, redintegration explains the mental activity itself. All three principles hold that integrating involves the process of one event instigating another; thus a stimulus evokes a response—the one instigates, and the other is instigated. In Hollingworth's opinion, however, the instigating factor is normally part of an original complex stimulus, and the instigated event is a total response rather than an isolated idea or a specific motor response. Hollingworth uses the terms *antecedent* and *consequence* as substitutes for stimulus and response because for him they more adequately describe the instigating and the instigated events respectively.

The concept of redintegration is similar to the Gestalt view of mind in that it stresses the unitary character of mental activity. It provides for a factor the importance of which Gestalt psychology minimizes; namely, the factor of past experience in the life of the organism. It explains, for example, the trained musician's *superior* ability to perceive relationships among the elements of a symphony. The musician appreciates the symphony by virtue of his training; the effects of this experience are redintegrated or "restored" when he hears the composition or any part of it, or when he thinks about it.

[1] Hollingworth, H. L. "Sensuous Determination of Psychological Attitude," *Psychological Review,* 1928, 93-117.

Therefore, redintegration, as opposed to Gestalt, explains how experiences become integrated.

Concluding Observation

Although the concepts of association, conditioning, configuration, and redintegration differ from each other, it does not follow that they represent *logically conflicting* points of view. After all, the psychologist who commits himself to one of these standpoints merely abstracts from a group of psychological phenomena certain features which to him are significant. Curiously enough, a principle which obviously underlies one phenomenon may seem fairly unrelated to another. Reverting to our introductory example of playing the piano, we may note that at one moment the pianist is associating ideas; at another moment he is conditioning a response or showing a conditioned response; and at still another moment he is reacting to the composition as a whole. But he is redintegrating while he is conditioning a response, he is perceiving relationships while he is manifesting redintegrative and conditioning activities, and he is conditioning a response while he is redintegrating, and so on. We may conclude, then, that each of the integrative theories primarily calls attention to one aspect of the integrative process by describing it from a particular (and from an arbitrary) standpoint.

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CHAPTER III

SENSORY AND PERCEPTUAL PROCESSES

A man is driving his car along a highway at the rate, say, of 45 miles per hour. Being none too well acquainted with the road, he watches ahead carefully for curves, bridges, irregularities in the road surface, railroad tracks, detours, and for the customary *signs* which warn him of the proximity of such dangers. He is also on the alert for other cars, particularly oncoming ones, and for hitch-hikers, live stock, overhanging branches of trees, and the like. He responds to *spatial and temporal relationships,* for otherwise he would be unable to pass cars and to avoid hitting objects, or even to keep on his side of the road. He has learned, for example, to estimate distance by the apparent size of objects and to make spatial adjustments accordingly; he has furthermore learned to judge the speed of an approaching car by the rapidity with which its apparent size increases; he has learned to judge the angle of a curve by the appearance of the white dividing line or by other visual cues. His auditory sense, too, plays an important rôle in his driving: he hears the sounds made by cars which are overtaking him, and he hears the sounds emanating from his own car. Notice that he pays little attention to the latter unless they happen to denote danger by their extraordinary character; thus, he may be unconscious of the sound of his motor until one of its cylinders begins to miss firing. During his driving, he is the recipient of kinesthetic, or proprioceptive, stimulations from the muscles, joints, and tendons of his body. Whether or not he is definitely conscious of these depends upon certain general circumstances which we shall discuss later; they are, however, absolutely indispensable for

his driving, and for any of his incidental movements while driving. But all of his sensory experiences are not essential to his driving. Likely as not, he will notice the colors of the changing landscape and the odors coming from orchards and fields, and he will observe that some of the villages through which he passes are busier than others.

Sensory-Motor Mechanisms. This common-place illustration calls attention to such aspects of mental activity and behavior as are directly related to the functioning of the sense organs, or receptors. It would be grossly misleading, however, to think of the receptors as being functionally distinct from the response organs or effectors, and from the neural mechanisms which connect the two. Leading from the receptors are nerves which go to the central nervous system, consisting of the brain and spinal cord; these are known as *sensory* or *afferent* nerves. Extending from the central nervous system are the *motor* or *efferent* nerves, which terminate in the muscles or glands. The receptors function by changing the energy of the stimulus into nervous energy—that is, by generating or inaugurating nerve impulses as the result of being stimulated. These impulses go to the central nervous system where they are "redirected"—to use a convenient expression—back to the effectors or response organs. Thus the receptors, the central nervous system, and the effectors constitute a system of neural circuits. The brain is that part of the system in which the most elaborate connections between afferent and efferent impulses are made. Figure 2 shows the important divisions of the central nervous system, and indicates the position of the central nervous system with reference to other parts of the body.

Psychologists refer to the physiological mechanism which functions when a response is made to a stimulus as a *sensory-motor* mechanism. The term implies that integrations are effected *between* sensory stimulations and motor responses.

The examples of behavior given in the preceding chapter illustrate integrations of this kind.

Sensory Processes. A sensory-motor mechanism is by no means a simple arc or circuit that receives a stimulus, converts

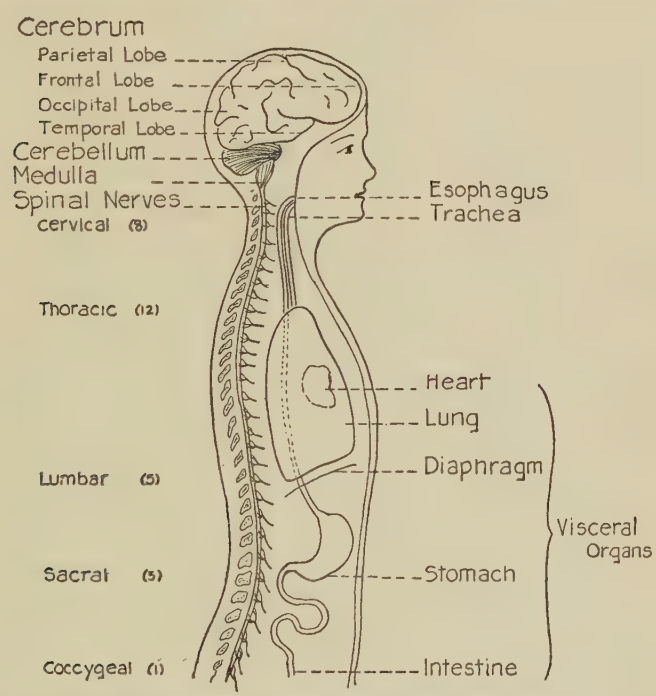


FIG. 2.—Schematic diagram of the central nervous system. Note that the 31 spinal nerves are grouped into five divisions.

it into a nerve impulse, and carries this impulse to a muscle fiber. The driver of the automobile does not merely respond to physical stimuli as such, nor does he react to aggregates, combinations, or configurations of physical stimuli. The approaching truck which he perceives is not a bundle of light vibrations and sound waves. On the contrary, he perceives objects in their spatial and temporal relationships, and he

reacts to such objects-as-perceived: he turns to the right in order to avoid colliding with the *truck*.

Such facts are generally recognized by psychologists and taken into account in their explanations of behavior. Thus, according to Warren and Carmichael (8), "Human psychology is the science which deals with the interaction between man and his environment by means of the nervous system and its terminal organs, together with the mental events which accompany this interplay." [1] By "terminal organs" they mean both the receptors and the effectors. It is quite obvious that an *interaction* between man and his environment implies something over and above *adaptation to* the environment. It assumes, in fact, that integrations are to be explained partly in terms of the mental interpretations of sensory experiences.

There is some justification, therefore, for the popular belief that man actually creates his environment. As every one knows, the world with animals and men left out would be a world devoid of colors, sounds, odors, heat and cold, and pain; furthermore, it would contain no objects in so far as "objects" depend upon the sense organs of living beings for their existence. It would be a world comprised of electrons and protons, atoms, molecules; perhaps it would consist of electrical energy and nothing else.

A sensory experience is a conscious state or activity that follows immediately upon the excitation of a sense organ. Psychologists classify sensory experiences into two groups; namely, *sensations* and *perceptions*. To the extent that the experience is correlated with physiological processes which occur in the sense organ, it is a sensation. Thus "red" is a sensation because it can be experienced only when a particular chemical change takes place in the eye. In one form of color blindness, the afflicted person cannot experience "red" because the retina of his eye lacks the so-called "red" molecule of the

[1] *Op. cit.*, p. 5.

eye. Sensations are classified according to the sense organs, hence there are as many classes of sensations as there are sense organs. Red, middle C on the piano, a toothache, and the experience of cold which results when a drop of ice-water falls on the hand are usually classified as sensations. As distinguished from a sensation, a perception involves the factor of meaning, based partly if not entirely upon past experience. Thus we perceive a rose as an object. Like sensations, perceptions are classified with reference to the sense organs: psychologists speak of visual, auditory, olfactory, cutaneous, and kinesthetic perceptual experiences.

It is highly important to realize that a perception is neither a group of sensations, nor a group of sensations experienced together with their "meaning." Sensations are *abstracted from* concrete sensory experiences; or, as Warren and Carmichael say, ". . . perception can be artificially analyzed into sensory and other elements."[1] After perceiving a red apple, a red automobile, and a red sky, one is able to abstract from them the sensory quality of "redness." Gestalt psychology is probably correct in contending that the most elementary form of sensory experience is perceptual experience.

The Nature of Sensory-Motor Integrations. All of the considerations so far advanced point to a very intimate relationship between changes in sensory stimulation and changes in the behavior of the organism. In discussing this relationship, we shall use the term *stimulus* to designate either the physical agent (such as light energy) which acts upon the organism, or the object or situation as perceived. This usage is necessitated by the fact that stimulus-response integrations are manifested by organisms as low as the ameba. Strictly speaking, sensory processes occur only in organisms which are equipped with receptors. The complexity of the sensory process, however, runs parallel with the morphological development

[1] *Op. cit.*, p. 143.

of the receptor: as we survey the animal scale from ameba to man, we find that all bodily structures, including the receptors and effectors, become increasingly more complex. Where the ameba reacts to light, the human organism reacts to objects, an apple for example, perceived through his visual receptor. Both the light and the apple are stimuli in the sense that they are the direct instigators of bodily movements.

The most general explanation of the relationships which obtain between stimuli and responses is furnished by the concept of purposive or adaptive behavior. In order to behave adaptively, an organism must "select" the stimuli directly involved in its movements. Sometimes this phenomenon is known as *attention,* but *selection* is the preferable term because it is less suggestive of conscious choice. We cannot ascribe any mysterious power or faculty of attention to animals in general when organisms as low as the ameba react as efficiently to their environment as man does to his. Selection, therefore, is a fundamental psychological phenomenon manifested by all organisms according to their biological composition.

To a large extent, selection is determined by purely objective conditions. An individual responds to a sudden and intense sound, to a blinding flash of light, and to a nauseating odor whether he wills it or not. This principle has been stated in the form of several laws, usually called the *objective conditions of attention.* Thus, the intensity, extensity, duration, and movement of stimuli are selection factors. All four of them find illustration in the electric signs displayed in cities. The characteristic of extensity is limited to visual and cutaneous stimuli, while that of duration applies to all. As every naturalist knows, animals react to movement, so that a carnivorous animal must stalk its prey. Occasionally the prey escapes destruction by feigning death. Movement is shown by cutaneous as well as visual stimuli. Even auditory stimuli change in a way analogous to movement: a melody "flows" or

"moves." According to Hunter (3), "movement is the fundamental objective condition of attention." [1]

Carr's (2) description of the processes which take place *within* the organism while it is thus reacting selectively to stimuli supplements the foregoing account of its behavior: "Every movement resulting from a sensory situation inevitably modifies that situation, and this change or modification of the sensory situation constitutes a new sensory stimulus which in turn modifies the act that produced it. There is thus a continuous process of interaction between sensory stimuli and motor responses. A stimulus arouses a movement, this response alters the sensory situation, this alteration of sensory conditions constitutes a stimulus that modifies the act, and this new response in turn arouses a stimulus that produces some effect upon the organism's subsequent behavior. Necessarily any living organism must be continually active. The validity of this proposition is easily demonstrated. Kinesthetic nerves are distributed to all striated muscles, and these sensory nerves are excited by muscular contractions, and these contractures necessarily affect the nerves that are distributed to these tissues. All movements can be directly perceived by means of these kinesthetic nerves."

Throughout the remainder of this chapter we shall discuss chiefly the sensory-motor integrations of the normal adult human being, and for reasons which have been stated, we shall refer to them as *perceptual-motor* integrations. Part of our discussion will be concerned with the perception of objects and situations. As Angell (1) says, ". . . sense perception gives us the real objects of daily life, the tables and chairs, cats and dogs, sticks and stones of everyday experience." [2] Our problem, then, will be to explain how the perceptual process *gives us* such objects. The psychologist accepts them as real, but at the same time, he regards them as experiences. Then,

[1] *Op. cit.*, p. 130.
[2] *Op. cit.*, p. 115.

we perceive situations as well as objects. We not only perceive Smith and Jones talking to each other, but we observe that they are quarreling. Finally, we cannot perceive objects at all without perceiving them in their spatial and temporal relationships. Thus the perception of space and time are abstracted phases of a general perceptual reaction.

The Senses

It is only in the interests of analysis that we can study any one of the senses apart from the others. To illustrate, many sensory factors are brought into play when we witness a wrestling match: our visual experiences, in fact, comprise a very small part of our total sensory reaction. We not only watch the struggle with our eyes, but we follow it with our muscles. We actually participate in the struggle. We duplicate the movements of the contestants, or we make opposite, compensatory movements. Thus we may either lean to the right when one of the wrestlers falls in that direction, or we may literally jerk ourselves to the left. In addition to these "sympathetic" muscular reactions, we move forward to the edge of the bench, jump to our feet in moments of particularly intense excitement, and perhaps shout with the rest of the spectators. All of this is accompanied by marked visceral disturbances. It is extremely probable, in fact, that all of our proprioceptors and interoceptors are subject to intense stimulation as we watch the performance. As regards our total sensory experiences, these proprioceptive and interoceptive stimulations furnish the background upon which the visual experiences are superimposed.

There is every reason to believe that these internal sensory stimulations likewise constitute the background for our relatively passive exteroceptive experiences. Even when we are lazily gazing at the clouds, apparently in a state of complete relaxation, we are also receiving sensory impressions from within the body. Physiologists have shown that the skeletal

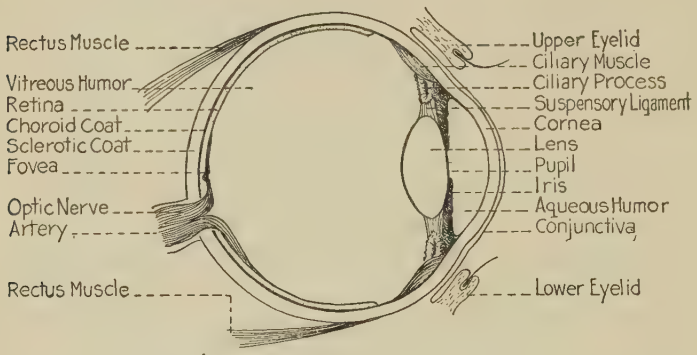
muscles are always in a state of tonicity: we are never completely relaxed even during sleep, or when under the influence of a general anesthetic.[1] And, of course, the respiratory, circulatory, and digestive systems of the organism function throughout its span of life. In one of the *Arabian Nights* tales, a decapitated human head continues to talk and to think; it actually seeks revenge upon the tyrant who separated this head from its body. But we can well believe that experiences which are mediated solely through the receptors of the head would be colorless and empty. In short, *this background of proprioceptive and interoceptive sensory impressions is the essential ingredient of our consciousness of self or of individual personality.*

With these general considerations in mind, let us note the important facts about the sense organs and their psychological functions. As a preliminary consideration, attention should be called to an erroneous belief concerning the number of receptors. The notion that there are five senses has prevailed for centuries, whereas, as a matter of fact, there are at least twenty. The cutaneous or skin senses alone number at least four; namely, touch, pain, warmth, and cold. Each is mediated undoubtedly by a specialized structure or sensitive cell. Incidentally, it should be noted that the skin itself is not a receptor. The cutaneous receptors are located in and beneath the skin, just as the visual receptor is located behind a movable skin and muscle covering, the eyelid. The skin is no more the organ of touch than the eyelid is the organ of vision. Furthermore, many of the receptors described below are located within the body and stimulated by forces from within. These are completely overlooked in the five-fold classification of the senses, one made before psychology became a science.

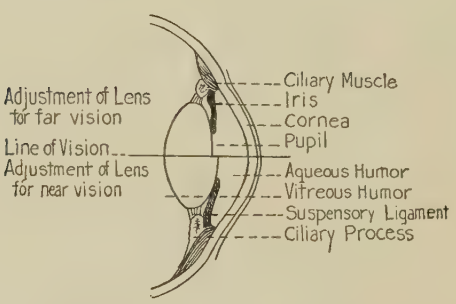
The Visual Sense. The eye is usually described as similar in operation to a camera. The counterparts of a camera found

[1] Consult Jacobson, E., "Progressive Relaxation," *American Journal of Psychology*, 1925, 36, 73-87, for a discussion of muscular relaxation.

in the eye (Fig. 3) are as follows: the eyelid is the external shutter; the pupil is the aperture that admits the light; the iris is the diaphragm; the lens resembles the camera lens; the



A. STRUCTURE OF THE EYE



B. MECHANISM OF ACCOMMODATION

FIG. 3.—Cross-section of the eye. *A* shows the parts of the eye and some of the structures adjacent to the eye-ball. *B* shows the difference in the curvature of the lens for far and for near vision.

dark, choroid coat of the eye, like the black inner surface of a camera, absorbs excessive light; and the retina corresponds to the sensitive plate or film. In the camera, focusing is accomplished by getting the proper distance between (1) lens and plate, and (2) lens and object to be photographed; in the

eye, focus is obtained by (1) varying the curvature of the lens, and (2) adjusting the distance between eye and object. Changes in the curvature of the lens are effected by the ciliary muscles to which is attached the suspensory capsule in which the lens is enclosed; the process is called *accommodation.* While the space within a camera is filled with air, the eyeball spaces are filled with two transparent substances, the aqueous humor and the vitreous humor. The retina is similar to the

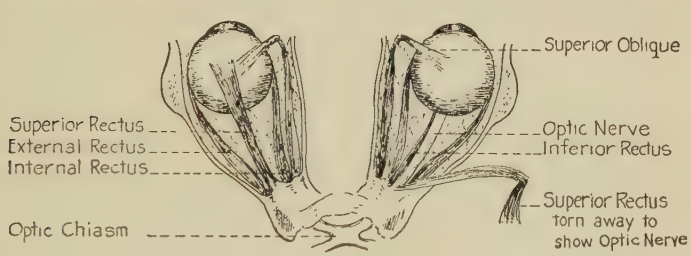


FIG. 4.—Muscles regulating eye movements.

sensitive plate in that it contains a photochemical substance; but in the eye this photochemical substance, being organic protoplasm, is being constantly renewed by metabolic processes. Moreover, retinal processes in the higher animals, particularly in man, are differentiated to react to "colors," or vibration rates of different frequencies. In brief, both eye and camera are mechanically constructed to receive the same physical stimulus and to direct this stimulus upon a chemically sensitive, plate-like structure.

In adjusting the eye to the stimulus, accommodation is not the only process involved. Just as the photographer moves his camera in position before regulating the focus of the lens, so the eyes are also moved into "position." Such movement is accomplished by muscles attached to the outer or sclerotic coat of the eye (Fig. 4). By means of these muscles the eyes may be moved horizontally, vertically, and obliquely. These are called *conjugate* eye movements. In addition, in fixating

upon near objects, as in reading a book, the eyes move *convergently* or toward each other. In fixating upon distant objects, as in witnessing a football game, the eyes assume a less convergent position. We thus have two principal kinds of eye movement, conjugate and convergent.

One of the essential conditions for vision is the formation of an *image* on the retina of the eye. A glance at the upper part of Figure 10, page 112, will show that normally this image is inverted. Light strikes the head of the arrow (either arrow A or B) and is reflected upon the lower portion of the retina: it must be reflected through the pupil of the eye in order to fall upon any part of the retina. Similarly, light which is reflected from the lower end of the arrow falls upon the upper portion of the retina. Contrary to popular belief, however, the fact that the retinal image is inverted has no special psychological significance. We "see things right side up when the image is upside down" because our habits are adjusted to this situation. As a matter of fact, we do not *see* the retinal image at all. One might as well ask how we can see a flat surface when the retina, and consequently the retinal image, is curved. Through the vibration rates that it directs into the eye, an object causes certain chemical changes in the retina of the eye; these in turn inaugurate nerve impulses that traverse the optic nerve; and finally, these sensory impulses result in a discharge of nerve impulses to the muscles. The end result is the perception of the object, and such motor responses as may follow upon this perceptual process.

Experimental evidence fully justifies this emphasis upon the rôle of motor habits in vision. The psychologist Stratton (6) once devised an instrument that, when fastened over one eye, the other eye being blindfolded, completely reversed the field of vision. Everything was seen upside down and all right-left relationships were reversed. When Stratton first put on this instrument, he experienced pronounced difficulty in executing the daily tasks that are normally quite habitual

and mechanical. For example, his attempts to eat dinner were almost disastrous. When, however, his everyday habits became adjusted to the inverted visual field, his visual experience ceased to appear unnatural. Stratton became habituated to the reversed visual cues in much the same manner that the student gets accustomed to the reversed and inverted movement of a microscopic slide.

The rôle of motor factors in vision will receive additional emphasis later in the chapter; meanwhile, let us examine briefly certain visual phenomena which are directly correlated with retinal processes. The outer, white wall of the eyeball is called the *sclera,* or the *sclerotic* coat; next to this, on its inner surface, is the *choroid,* a dark coat which absorbs excess light and thus serves the same purpose as the black lining of the camera. The *retina* is a thin, transparent structure, forming the third and innermost coating of the eye. It contains a hundred or more millions of minute sense cells, the *rods* and the *cones;* these are the true sense organs of vision. The *optic nerve* is a cable containing the nerve fibers, or neurons, which transmit afferent impulses from the eye to the brain. These fibers originate at all points on the retina. They come together at the *blind spot* of the retina, which is situated toward the nasal side of the eyeball. This area, as the term implies, contains no rods or cones. Normally, a person is unaware of his blind spot, yet he can discover it by closing one eye and gazing with the other at a point located near a black disc. Figure 5 demonstrates this procedure. For ordinary purposes, the *fovea* of the retina is the point of clearest vision. It is located at the center of the retina, at a point determined by a line which extends from the pupil through the center of the eyeball.

Visual sensations consist of two groups, the chromatic or color series, and the achromatic or brightness series. The latter comprises the color experiences which extend from "jet" black through the grays to the purest white. According to Titchener, the human observer can distinguish approximately

150 colors, and over 600 differences in the achromatic series. Color sensations have three characteristics: they differ in their color-tone or hue—that is to say, their "color"; they differ in brightness—yellow, for example, is intrinsically brighter than purple; and they differ in that some colors are more saturated, or "richer," than others. It has been estimated that when all of these differences are taken into consideration, the human observer is capable of making about 35,000 discriminations among visual sensory experiences.

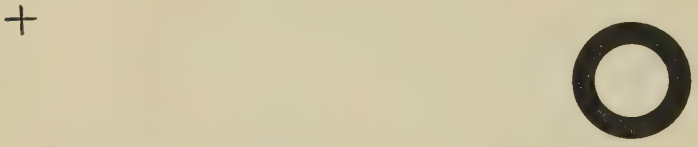


FIG. 5.—Diagram to demonstrate the blind spot. Close the left eye, and keeping the right eye fixed on the x mark, move the diagram towards the eye and away from it till a point is found where the black disc disappears. (Diagram and directions modified from E. C. Sanford's *A Course in Experimental Psychology, Part First,* D. C. Heath and Co., 1895.)

Under normal conditions of color experience, light waves of different vibration rates enter the eye through the pupil, fall upon the retina, and, according to theories of color vision, effect certain changes in chemical substances contained in the rods and cones. It is usually assumed that these changes are catabolic in character; that is, they involve a temporary decomposition of these substances. Since so many color effects can be produced by mixing a few colors, these theories assume that there are as many kinds of photochemical substances in the rods and cones as there are elementary or primary colors. Psychologists tend to believe that blue, yellow, red, and green, together with black and white, comprise the primary color experiences. Black, of course, is a sensory experience, and not the mere absence of white or of color—a black tie is *seen,* just as a white or a red tie is seen.

Among the important visual phenomena which color theories attempt to explain are positive and negative after-sensations, and complementary color combinations. After gazing at a strong light for a moment and then closing the eyes or looking at a neutral wall, one may notice a positive after-sensation. This after-sensation, or after-image as it is usually called, corresponds in color to the light stimulus. It persists, however, only for a second or two, or perhaps a fraction of a second. Negative after-sensations illustrate the phenomena of color complements: after looking at a red square of paper for a few seconds, one may get a greenish after-image. As similar tests show, blue is the complement of yellow, and black is the complement of white. In general, the after-image of any blend of colors is a corresponding blend of their complements. If a color is placed beside its complement, each tends to increase the richness of the other, particularly along the margin formed by their junction. This is the phenomenon of *color contrast*, so extensively used in color designing. The explanation is simple: if we gaze at a yellow square placed upon a blue background, we get a blue after-sensation of the yellow stimulus, hence when we look at the blue while experiencing the blue-colored after-sensation, we are adding blue to blue, thereby obtaining more blue. Conversely, our yellow after-sensation caused by the blue background enhances the saturation of the yellow. It is for this reason that complementary colors form "loud" combinations. In order to explain these phenomena, color theories assume that the photochemical activity *persists* after the stimulus has ceased to act upon it, thus prolonging the actual physiological stimulation which gives rise to the sensory experience. They further assume that the molecules which constitute the photochemical substances are double molecules. One half of a particular molecule, so to speak, is responsible for red, while the other half gives green. So-called "red" light sets up a chemical activity in the "red" half of the molecule, but since this tends to spread to the other

half, the experience of red is followed by the experience of green.

Color sensitivity is not uniformly distributed over the retina. The outermost portion of the retina, called the *periphery*, gives achromatic sensations only. Moreover, the periphery is more sensitive to faint or minute achromatic stimuli than is the central part of the retina: in order to see distinctly a star that is barely visible, one should fixate on an imaginary point to one side of it. The region of the fovea yields all chromatic and achromatic sensations, while the intermediate part of the retina, between the fovea and the periphery, mediates brightness sensations, and blue and yellow, but not red and green. The periphery corresponds to the primitive eye, for as we go down the animal scale, we find with some exceptions a decreasing capacity to react to colors, and relatively increasing sensitivity to brightness. Since the fovea is most highly developed in man, its special sensitivity to red and green points to these colors as being recent acquisitions in phylogenetic history.

This sketch of the important visual phenomena calls attention to the nature of retinal mechanisms. As we have said, visual sensations are abstracted qualities of objects which are perceived through the eye: when we see a red apple, the redness is a characteristic of the apple, and not a pure sensation, localized or experienced *in* the retina. Although a more detailed analysis of visual sensations would be of interest in itself, it would contribute little to our knowledge of visual perception and its function in behavior.

The Auditory Sense. The organ of hearing (Fig. 6) is a complicated structure encased in the temporal bone of the head. The external ear is a crude trumpet for directing sound waves into the tube leading from it, the external auditory meatus. Deaf people frequently reënforce this function by holding their hands back of their ears while listening. Sound vibrations are transmitted through the middle ear by various

structures, including a membrane and a lever-like arrangement of three small bones that decrease the amplitude and increase the force of these vibrations. The actual organ of hearing is an exceedingly complicated device in the cochlea of the inner ear, immersed in liquid. According to one theory of audition, this device consists of minute vibrating bodies, each of which

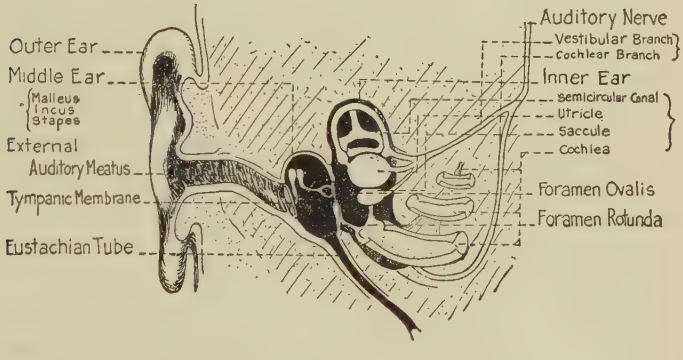


Fig. 6.—Cross-section of the ear.

responds to a given vibration rate or to a limited range of vibration rates; it is essentially a harp-like structure, with a sensory neuron attached to each of its "strings." Other theories maintain that it would be physically impossible for any cochlear structure to function in this manner, and hold that vibration patterns are set up in the auditory organ when it is affected by a given vibration rate. It is generally agreed, however, that in some way the organ of hearing differentiates among pitches.

Auditory sensations fall into two major groups—tones and noises. A tone is heard when periodic vibrations affect the organ of hearing, while a noise results from non-periodic vibrations. A noise may be thought of as a "scrambled" or broken-up group of tonal elements. The *pitch* of a tone corresponds to the frequency of the vibrations: the musical scale

ranges from approximately 16 to 4,000 vibrations per second, while the audible scale extends from a minimum of 12 or more to a maximum of about 50,000 vibrations. It is difficult, however, for the untrained observer to detect a definite pitch below 20 or above 25,000 vibrations per second. *Tone islands* are found in persons suffering from defective segments of the auditory organ; that is, they hear certain pitches but not others. The *intensity* of the tone corresponds to the amplitude of the sound wave. Finally, the tone *quality* depends primarily upon the form of sound wave. Usually a vibrating body, such as a taut wire, breaks up into halves, thirds, fourths, etc., when it is set into motion, and thus produces numerous partials or over-tones in addition to its fundamental tone. These partials give the tone its *timbre*. By form is meant, then, this complex sound wave, comprising the vibration rates corresponding to both the fundamental and its overtones. But tone quality is not based entirely upon timbre: most tones, even those produced by musical instruments, are accompanied by noises. A tuning fork gives a relatively pure tone, but a symphony played upon tuning forks would offend one's musical sensitivity.

The Olfactory Sense. Olfactory stimuli are particles coming from the objects which are "smelled." Although the olfactory receptor does not possess the complicated accessory structures found in the eye and the ear, mechanisms for placing it in contact with its stimuli are not lacking. These are expressed in the act of scenting and sniffing, involving body and head adjustments, movements of the nose itself, and respiratory changes. This adaptive act literally brings the olfactory stimulus to its receptor; a counter-adaptation is the act of holding the breath and sometimes the nose.

Little progress has been made in classifying olfactory sensations—as Angell explains, they are confused with tastes ("sour" or "sweet" smells), or named after the objects from which they emanate (such as a "lemon" or a "rose" odor), or

simply labeled as agreeable or disagreeable.[1] The following classification, made originally by the Swedish botanist Linnæus (1707-1778) and later modified by the Dutch physiologist Zwaardemaker, is of interest chiefly because it demonstrates the anomalous character of olfactory experiences: (1) ethereal odors—fruit, wine, etc., (2) aromatic odors—spices, camphor, geranium, etc., (3) fragrant—flower smells, vanilla, etc., (4) ambrosiac—musk, etc., (5) alliaceous—onion, garlic, asafœtida, india-rubber, dried fish, chlorin, iodin, (6) empyreumatic—burnt foods, roasted coffee, toast, tobacco smoke, etc., (7) hircin—stale cheese, sweat, lactic acid, etc., (8) virulent—opium, certain insects and plants, etc., (9) nauseous—decaying animal matter, etc.

Á propos of this classification, Titchener (7) makes the following comment: "Many of the stimuli mentioned in the list have sensory effects that extend far beyond the domain of smell. Thus the two ordinary anesthetics, chloroform and ether, belong as scents to the ethereal group. But, further, inhaled chloroform tastes sweet, and inhaled ether bitter; while both stimuli may, by diffusion, give rise to sensations of cold and, by direct application, to sensations of pain. Pungent odors (ammonia, pepper, mustard) arouse pricking or tingling sensations in the nose and throat. The smell of onions and of horse-radish brings tears to the eyes; in some cases, the smell of hay or of newly turned garden mold has an unpleasant effect upon breathing. Odors of the eighth and ninth classes may excite the sensation of nausea." [2]

The Gustatory Sense. While taste sensitivity is found chiefly upon the tongue surface, it is also distributed over the palate and throat, and, according to some authorities, over the inner lining of the cheek. The *taste bud,* or the gustatory receptor, is a minute sack containing a number of sensory nerve cells. Since the stimulus for taste is a substance in solu-

[1] *Op. cit.,* p. 106.
[2] *Op. cit.,* p. 118.

tion, taste buds open upon the surface of the membrane in which they are lodged and thus permit the stimulus to come in direct contact with the taste cells.

It is interesting to note that the tongue surface is divided into specialized taste areas. The tip is sensitive to sweet and salt, the sides to acid or sour, and the back or base of the tongue to bitter. Studies of gustatory sensitivity have yielded only these four elementary sensations. This is not surprising in view of the fact that most "taste" experiences are blends of gustatory, olfactory, thermal, and contact sensations. Thus, ice-cream involves sweet and cold, and a smooth cutaneous experience best described by the word "oily"; coffee can be analyzed into sweet, bitter, heat, and contact; unseasoned roast beef, particularly when eaten by the victim of a bad cold, is practically tasteless. More than any other sense, smell of course is likely to be confused with taste.

According to Herrick, taste in man is wholly interoceptive, in the sense that nerve impulses from the taste organs affect internal and visceral functions, and not the orientation of the body with reference to its environment. Nevertheless, taste stimuli come from without, so that logically taste could be exteroceptive; it is partly exteroceptive, in fact, in certain fishes.

The obvious function of taste is to provide for the intake of proper and the rejection of improper food. Together with the thermal and touch exteroceptors located on the tongue, taste buds send nerve impulses that ultimately discharge into the neuromuscular and glandular mechanisms of the digestive system. If the stimulus is customary, and chemically suitable, these impulses result in mastication, swallowing, peristalsis, and glandular activity; if unusual or chemically noxious, they inhibit these activities and occasionally produce antiperistalsis.

The Cutaneous Senses. The contact receptors are small organs found for the most part in and just beneath the skin.

They give rise to sensations of touch or pressure, heat, cold, and pain. Some idea of their appearance can be formed by studying Figure 7. According to some authorities they include, in addition, numerous organs deeply embedded in bodily tissues, called the Pacinian corpuscles. These corpuscles are supposed to mediate deep sensitivity. Several organs seemingly are responsible for touch, including nerve endings in the

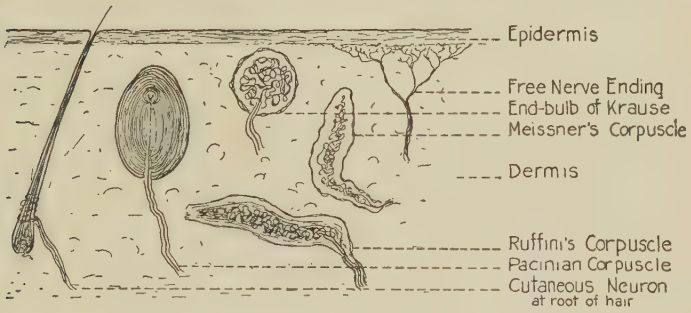


FIG. 7.—Cutaneous receptors.

hair bulbs at the roots of the hairs. It is usually assumed that Merkel's corpuscles and Meissner's corpuscles are touch receptors. Two other structures, Ruffini's cylinder and the end-bulb of Krause, are supposed to mediate warmth and cold respectively. The structure ordinarily regarded as the organ of pain is merely a free nerve ending, or a nerve with no receptor attached.

Sensitivity to the four kinds of cutaneous stimuli is not found uniformly over the skin, but is distributed irregularly over the body surface, touch spots, in particular, being found on areas of the skin (end of the tongue and finger tips) used for exploratory purposes. By employing a rather simple experimental technique, involving the application of various stimulating instruments to the skin, it is possible to locate the four classes of sensitive spots on a given skin area.

Since the membranes found within the body as well as the

skin are composed of epithelial tissue, the possibility of internal touch, warmth, cold, and pain is suggested. But evidence points to the absence of tactile and temperature sensitivity in the viscera, and to an irregular distribution of pain sensitivity. In general, while visceral organs are relatively insensitive to pain, portions of their surrounding membranes, such as the peritoneum, the pleura, the pericardium, and the meninges, are partly or entirely sensitive to certain forms of pain stimuli. Some forms of visceral pain are accurately localized by subjects or patients; other forms, known as referred pains, are projected to parts of the body quite removed from the sources of stimulation. Thus a pain caused by an ulcerated condition in the colon, or large intestine, may be experienced in the shoulder. The explanation of this phenomenon is found in the fact that when the sensory neurons or nerve cells from the viscera reach the ganglia [1] just outside the spinal cord, they connect with sensory neurons coming from the body surface. The neuron from the body surface carries the visceral as well as its own nerve impulses with the result that the visceral pain is referred to the exteroceptive source.

Such acts of behavior as are made in response to stimulation of contact receptors show certain characteristics that explain their function. In studying animal behavior, we observe that certain responses are easily aroused by cutaneous stimuli, examples being scratching parts of the skin, preening feathers, moving the tail, quivering, trembling, starting and withdrawing movements, licking parts of the body surface. Evidently skin sensitivity serves to bring beneficial stimuli in closer contact with the body, and to remove obnoxious stimuli from the body. In general, cutaneous reflexes are definite and well developed, for they are elicited by stimuli touching the organism itself. Responses made to distance receptor stimulation are characteristically anticipatory or preparatory in that

[1] A *ganglion* is a group of nerve centers located outside of the central nervous system.

they lead up to a final and culminating response. As opposed to these, responses to contact are necessarily final, for whether the stimulus is amicable or inimical, it is at hand and it must be disposed of. The cringing, withdrawing response caused by touching a repulsive object is, on the whole, even more violent than the same response aroused by seeing the object. A corresponding greater intensity of the cutaneous response can be observed when the stimulus evokes a forward-going reaction. In describing their own reactions, people testify to the compelling nature of cutaneous stimuli. For instance, if "the skin you love to touch" produces an intense favorable response, a skin that is repulsive, by virtue of its color or perhaps its hygienic condition, produces an unfavorable response no less marked. In terms of behavior, repulsive and attractive as applied to stimulating objects are no mere figures of speech. They express the demonstrable behavior tendencies of the organism confronted with certain stimulating objects; and these tendencies originated as contact responses.

The Proprioceptive Senses. The receptive organs of the body, such as the semicircular canals of the ear, as well as those found in the muscles and tendons and on the joint surfaces, are called proprioceptors because their adequate stimuli are furnished by (or are the "property" of) the organism itself. The canals contain a liquid, variations in the pressure of which presumably stimulate adjacent sensitive nerves. The proprioceptors embedded in the muscles and tendons are stimulated by the surrounding tissue. The stimulations become strong when the muscles are active or tense. The proprioceptors on the joint surfaces are stimulated by movements of the joints.

The proprioceptive system can be compared with the differential of an automobile, a device that automatically regulates the fine movements of a car by distributing the power in correct proportions to the rear wheels. Although gross motor responses are effected by exteroceptors, the muscular

coördination that normally characterizes these responses is effected by proprioceptors. The latter are divided into two classes, the organs of static sense, and the kinesthetic organs. Each has a special function in effecting coördination.

(1) The organs of static sense and bodily equilibrium are the semicircular canals, including the saccule and utricle of the inner ear. They regulate automatically the responses of the organism whereby its equilibrium is maintained, illustrated by the balancing reflexes of the trained (or untrained) tight-rope walker; and they regulate in general all efforts of the organism to maintain and alter its bodily postures and attitudes. As stated above, it is commonly assumed that the stimulus for the organ of the static sense is its own liquid, pressing with varying and changing degrees of intensity at different places on the confining walls of the organ as the head moves. By setting the appropriate neuromuscular mechanisms in action, the organ coördinates adjustments that otherwise would be jerky and awkward. It is usually held that the receptors of the semicircular canals are activated in turning or rotary movements, while the saccule and utricle are activated in straight line or rectilinear movements.

In connection with semicircular canal functions, Titchener mentions the danger attending deaf mutes who indulge in rides on merry-go-rounds, or in deep water diving. In the one case they tend to sit upright, irrespective of the speed at which they travel, whereas the normal person unconsciously "banks" in toward the center; and consequently they are in danger of being thrown off. In the case of deep water diving the deaf mute is in danger of losing his spatial orientation and consequently of drowning.[1] In both cases, of course, the deafness is purely incidental, for the injury to the canals, located near the organ of hearing, is the cause of the difficulty.

(2) The kinesthetic organs are located in the muscles and tendons (Fig. 8), and on the joint surfaces. The term kin-

[1] *Op. cit.*, pp. 178-179.

esthetic literally means feeling of motion, but since we are seldom conscious of the sensations caused by these organs our chief interest is in their functioning. The endings, or functionally the beginnings, of afferent neurons (that is, nerve cells which carry impulses from the receptors to the brain or spinal cord) are found in the muscles, wound spirally around individual muscle cells. On tendon surfaces are found branch-like beginnings of afferent nerves, and the synovial membrane lining the joints is supplied with receptors. We have already

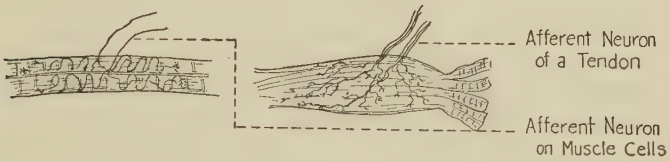


Fig. 8.—Kinesthetic receptors in muscles and tendons.

noted that kinesthetic receptors are stimulated by the contraction of muscle cells, the tension of the tendons, and the rubbing of one joint surface on another when some muscular act is taking place. Kinesthetic stimuli are thus forms of contact stimuli.

Kinesthetic receptors function by generating nerve impulses that regulate muscular activity. Their importance is demonstrated in the familiar mirror-tracing experiment, in which a subject traces some simple design, usually a star, with a pencil, on the design reflected from the mirror. Under the conditions of the experiment the visual cues are reversed, thus breaking up the established visual-kinesthetic cues, and making the execution of the act quite difficult. These cues are combined through habit, for in the everyday acts of dressing and shaving before a mirror the same conditions obtain that characterize the mirror-tracing experiment.

In the disease *tabes dorsalis,* also called *locomotor ataxia,* a degeneration in the spinal cord primarily affects nerve tracts

from the cutaneous receptors and proprioceptors. The resulting symptom is an extreme clumsiness of gait and of manipulatory habits. When the normal person with both legs or feet "asleep" tries to walk, he practically duplicates the tabetic gait. In the absence of kinesthetic cues from his feet and legs, he relies on visual cues that are inadequate for smooth or coördinated muscular activity.

The Interoceptive Senses. Notwithstanding the fact that the proprioceptors are located internally, they belong to, and are adjuncts of, the exteroceptors. The true internal receptors are located in the viscera. Aside from the organs of taste and smell they have not been definitely identified or described. Since many visceral activities, such as the secreting functions of gastric glands, may take place independently of nerve control, we cannot assume that interoceptive stimulation is the sole condition for visceral functioning, either muscular or glandular. There are, however, afferent connections between the viscera and the cerebrospinal nervous system, as well as connections in the autonomic system that are both afferent and efferent, so that the existence of interoceptive impulses cannot be questioned.

Because they report the physiological condition of the bodily organs, sensations arising from the interoceptors are called *organic* sensations. They are classified according to the physiological systems in which they originate, *viz.*, the respiratory, circulatory, digestive, and reproductive systems respectively. Examples of organic sensations are hunger, thirst, nausea, the experience of being suffocated, dizziness, erotic excitement, and the more general feelings of drowsiness, fatigue, and physiological well-being. To this list should be added the abnormal experiences occasioned by alcohol, cocain, morphin, and other drugs and stimulants. In another chapter it is explained that the basic emotions (fear, love, anger, and the like) all contain a core of organic sensations.

The Perception of Spatial and Temporal Relationships

The perception of an object ordinarily involves a perceptual response to its size and shape, its position with reference to other objects, and its movements—in so far as its position shifts about in its setting. Such responses are mediated primarily through the exteroceptors; that is, through the receptors which guide the organism around in its environment. The eye is preëminently the spatial sense organ because it gives us the three spatial dimensions simultaneously. One glance at a box suffices to tell us that it has height, width, and depth. Unaided by vision and by kinesthetic sensitivity, the cutaneous receptors report area or two-dimensional space. In the absence of visual cues, for example, we usually explore an unfamiliar object with our fingers in order to form some idea of its size and shape. This procedure makes use of the kinesthetic sense, and it furthermore increases the area of tactual stimulation. As regards its contribution to our spatial responses, audition is the poorest of the exteroceptive senses. Upon hearing the sound of an airship, we are positive merely that it is somewhere in the sky—we must determine its position through our visual sense. In a familiar laboratory experiment, the inadequacy of auditory localization is demonstrated by the marked inability of a blindfolded subject to point to the source of clicking sounds, produced at various places around him: he is accurate only in locating the sound to the right or the left of his head. Smell has no intrinsic space qualities whatsoever, save that odors are supposed to pervade or occupy space; in other words, odors are thought to possess the quality of "voluminousness." Knowledge or a guess and not some characteristic of the olfactory experience itself usually enables us to locate the source of odors. The direction of the wind is one of our main cues when we attempt to locate such a source out-of-doors. It appears, then, that vision and touch,

coöperating with the kinesthetic senses, are chiefly responsible for our apprehension of spatial relationships.

Single and Double Vision. Binocular vision means, simply, seeing with the two eyes. The mythological creature, Cyclops, had only one eye, located in the middle of his forehead. Since he possessed just the one retina and the one optic nerve, he could have only one retinal pattern of stimulation at any given moment. But the human being has two eyes, each of which may function more or less independently of the other; hence we may wonder why he does not see everything doubled in binocular vision.

As a matter of fact, double vision or *diplopia* is a commonplace phenomenon. Focus your eyes upon an object and it is seen as single; then press on the lower lid of either eye, just enough to displace the eyeball slightly, and you get double vision. Alcoholic beverages produce double vision by interfering with the motor coördination which normally keeps the two eyes in focus on one object at a time. As the following experiment shows, however, displacement of one eyeball is not an essential condition of diplopia. Hold a pencil in a vertical position about a foot in front of your eyes so that the pencil top is in the line of vision which extends from the point halfway between the two eyes to a telephone pole, located, say, across the street. Look at the pencil and the pole is doubled; then look at the pole, still holding the pencil in the same position, and the pencil in turn becomes doubled.

This experiment enables us to describe the conditions under which we see objects as single or as double. The two eyes in Figure 9 are focused upon the object, B; in other words, they are sufficiently converged to throw the two images of B—one for the right and one for the left eye—upon *corresponding* parts of the two retinæ. Since this is the normal condition of focus, B is seen as a single object. But the two images from A, as well as the two from C, fall on non-corresponding areas of the two retinæ, and both A and C are doubled. Notice that

the respective images of A and C do not even fall upon corresponding quadrants of the two retinæ, indicated by the small letters, a, b, c, d, and a′, b′, c′, d′. We may conclude, then,

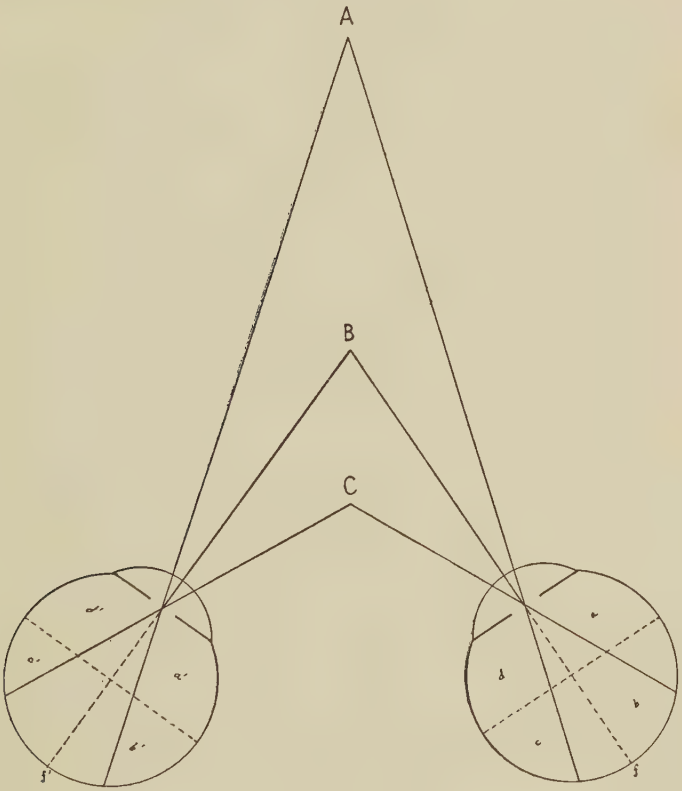


Fig. 9.—The position of the eyes in single and in double vision.

that an object is perceived as single when its images fall upon corresponding areas of the two retinæ, and seen as double when its images are cast upon non-corresponding areas of the two retinæ. In connection with this law, attention is called to the fact that normally the two eyes of a person are always

slightly converged—even when he gazes at an object as far removed as the north star. We are so seldom conscious of this fact that if we were to see the two eyes of a person in a parallel position, we would judge them to be "wall-eyed" (the condition known as divergent strabismus).

The normal condition of single vision as just described is not found in the cross-eyed or "wall-eyed" person. Neither is it found in a bird. However, there is nothing mysterious in the fact that neither of these organisms is afflicted with diplopia: the man with a cast in one eye learns to ignore stimuli which affect it, and to use habitually the other eye. And after observing the head movements of a parrot, for example, we infer that it merely uses one eye at a time. For that matter, all of us get double images which we habitually ignore. In Figure 9, B can be taken to represent any object upon which we focus our eyes at any given moment, while A and C represent respectively objects in the background and in the foreground of our vision. A study of Figure 10 will show that it is possible to draw straight lines from the various corresponding points on the two retinæ, out through the two pupils. Each pair of lines would converge and finally meet at a point in front of the eyes, and a line consisting of these points would indicate the position of objects which would be seen as single. Notice that the diagram shows only one horizontal cross-section of the eyes; if we had a model in three dimensions, rather than a two-dimensional diagram, this model could be used to demonstrate all points in space where objects are seen as single objects. Such points, from the position of the eyes themselves, constitute a concave surface, or roughly a bell-shaped surface, known as the *horopter*.[1]

It may be of interest to know that we can get double images in monocular vision. *Scheiner's Experiment* demonstrates this phenomenon. Pierce two pinholes, on a horizontal line, a sixteenth of an inch apart in a white cardboard; stick two

[1] See Titchener, *op. cit.*, p. 310, for a picture of the horopter model.

pins in an upright position on the surface of a table, one eight inches and the other twenty inches from the edge of the table; then close one eye, and while holding the cardboard close to the other, so that you gaze through both pinholes, look first at the near pin and afterwards at the far pin. In both instances, you will see that the pin on which you focus your eyes is single, and that the other one is doubled. If, while looking at the near pin, you will cover the left pinhole, the left image will disappear; but if you repeat this while looking at the far pin, the right image will disappear. In order to understand these phenomena, it is necessary to remember that the surface of the lens of the eye assumes a greater degree of curvature in near than in far vision; the lens becomes thicker, or it bulges more, in near vision than it does in far. When you look at the near pin, your lens is in such a position that the light stimuli coming through the two pinholes is made to fall upon two different parts of the retina; hence you really see two pins. The same thing happens when you look at the far pin.

Binocular Depth. Binocular vision also plays a rôle in the perception of depth, solidity, or the third dimension. The lower part of Figure 10 represents the pathways of stimuli to the right and left eyes respectively. The two retinal images are slightly dissimilar, the image on the right retina representing relatively more of the right side of the three-dimensional object, the image on the left eye representing more of the left face of the object. This is the natural or habitual situation that obtains when one views a solid object; hence, when this condition is reproduced artificially, we have the visual *illusion* of depth.

This illusion can readily be demonstrated by the stereoscope. In our grandfather's time, one form of this instrument with its set of pictures had a place on the parlor table. It is now to be found in every psychological laboratory. The picture or stereogram which is used consists of two slightly dissimilar photographs or drawings placed side by side on a strip

of cardboard. The picture to the right represents the object (the full moon, or perhaps the Eiffel Tower) as it is normally seen by the right eye, while the left picture shows it as seen by the left eye. The photographs of the stereogram are taken

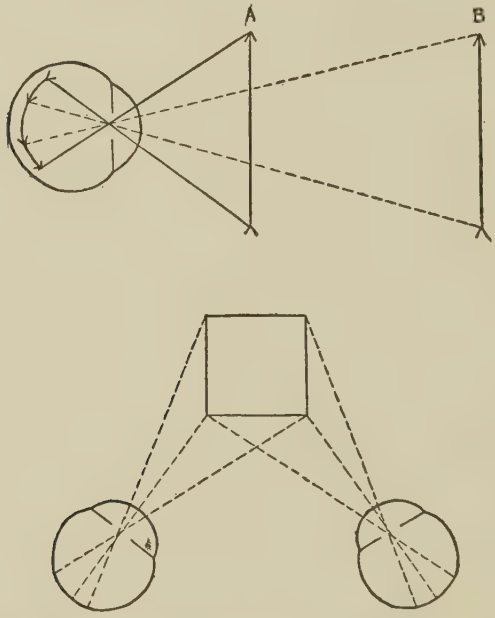


FIG. 10.—The mechanism of monocular and binocular vision (schematic). The upper figure shows (a) the inversion of the retinal image and (b) the relationship between the size of the image and the distance between the object and the eye. The lower figure shows the difference in the retinal images of the two eyes when the stimulating object is solid.

by two cameras converged at the same angle as the eyes in normal vision. The familiar refracting stereoscope, invented by Brewster in 1850, contains two wedge-shaped pieces of glass, one for each eye. Since, as we have noted, the two eyes are invariably somewhat converged, the glasses, or prism-lenses, are needed to direct the light stimuli from the respec-

tive pictures upon corresponding areas of the two retinæ. That is, they refract the light waves toward the temporal sides of the two retinæ, and away from their nasal sides. An opaque screen, placed in a vertical position at a right angle to the cardboard, enables each eye to see only its appropriate picture. Notice that the stereoscope itself merely insures single vision; if the two pictures were not dissimilar, we would get single vision but not binocular depth.

There are several devices for producing the stereoscopic effect. Wheatstone invented the first stereoscope in 1838. He used mirrors, however, and not prism-lenses, and thus reflected the two pictures upon corresponding areas of the two eyes. Another instrument for obtaining the binocular illusion of depth consists of a cardboard lorgnette-like device, which contains a red square of glass or mica to be placed in front of one eye, and a green square to be placed in front of the other. The stimulus-card contains a red picture of the object, showing it as seen by one eye, and a green picture, taken from the correct angle for the other eye; the one colored picture is superimposed upon the other, but placed slightly to one side of it. The double picture, in fact, suggests a two-tone lithograph in which the colors are imperfectly placed. In looking at the stimulus-pictures through the colored squares, however, we get not a colored picture but an achromatic or a neutral one, and we get depth as well. Since the colors are complementary, they neutralize each other to produce the achromatic effect, and in addition, the colored square in front of each eye permits this eye to see only its appropriate, colored picture. The two colored pictures do not occupy exactly the same areas on the stimulus card, and consequently they do not fall upon exactly corresponding retinal areas; but they are sufficiently close together to create the effect of single vision. Still another device was used at the Selwyn Theatre in New York City a few years ago. Each seat of this theater was equipped with an electrical apparatus containing a rotating sector of

a disc, through which the patron viewed a motion picture. Without the use of the device, the picture was blurred. It was in reality a double picture, consisting of pictures projected alternately and in rapid succession for the right and for the left eye. As the picture was being projected, the rotating sector, which was synchronized with the speed of the projection machine, permitted each eye to see its part of the double picture. The result was a perfect stereoscopic effect. But

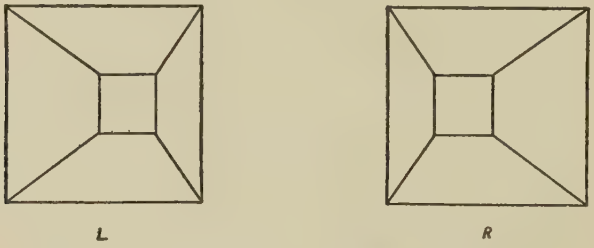


FIG. 11.—Stereogram of a truncated pyramid.

stereoscopic depth can be obtained by a more simple procedure than any so far described. Figure 11 is a stereogram, showing a truncated pyramid as seen from above. The right eye sees more of the right side of the pyramid while the left eye sees more of the left side; hence the top of the pyramid is drawn towards the nasal side of the eye in both parts of the figure. In order to fuse the two drawings, you must focus your eyes on some imaginary point beyond the diagram. This will decrease the angle of convergence, thus throwing the two images upon corresponding points of your retinæ. Notice that you see three pictures—a middle, or fused, picture showing stereoscopic depth, and two outside flat pictures. By substituting a playing-card or an index card for the vertical screen of the prism-lens stereoscope, you will intercept the lines of vision between the right-hand picture and the left eye (and vice versa) and thus get only the middle, or fused, picture.

Psychological Factors in Visual Depth. We must not overlook the fact that we perceive depth in monocular vision. We are less accurate in judging distance with one eye closed. Using only one eye, try threading a needle, lighting a cigarette, or picking up a pin. The general spatial orientation to depth, however, remains substantially unimpaired when we change from binocular to monocular vision. This is of interest when we realize that the retina is a two-dimensional surface. The retinal image (that is, the stimulated retinal area) has height and width, but not depth. Although it represents one object in the visual field as above or below or to the right or to the left of another object, it cannot superimpose one object upon another to indicate differences in their respective distances from the eye.

The psychological conditions of depth perception are illustrated by the principles shown in drawings and paintings on flat surfaces. Near objects form larger retinal images than do far objects, hence the artist creates the illusion of distance by drawing objects in different sizes. A distant tree in the drawing is much smaller than a near-by tree. In the second place, the artist utilizes the principle of linear or geometrical perspective. Notice that when you look at an actual landscape, objects far in the distance are higher than are the near ones. The artist gets this effect upon his flat surface by drawing far objects towards the upper part of his picture, and near objects towards the lower part. The actual horizon, however, is invariably on the level with the eyes: no matter how high you climb in an airship, the horizon never drops. According to the principles of formal art, the horizon is indicated in a drawing by a horizontal line which divides the drawing into two equal parts. A third principle is concerned with intervening objects. An object which partly covers another is perceived as being the nearer of the two. Aerial perspective refers to the fact that as objects recede into distance, they lose their distinctness of outline, and their colors become

less saturated. Colors possess intrinsic depth values: objects in paintings are brought forward by being colored red and pushed backward by being colored green. Finally, the artist employs *lights* and *shading* to indicate distance. A high light comes from the near part of an object while shading is associated with a receding surface. Figure 12 illustrates some of the principles which govern illusions of depth.

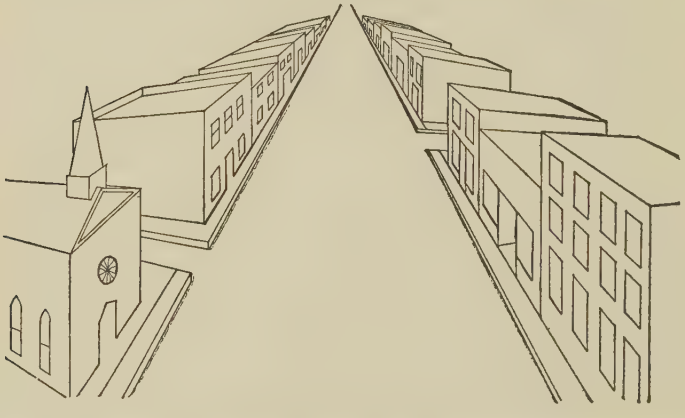


FIG. 12.—Diagram to illustrate some of the factors in monocular depth. Suggested by a diagram in Dashiell's *Fundamentals of Objective Psychology.*

The Law of Visual "Projection." To say that we perceive distance is another way of saying that we "project" our visual experiences out into space. A simple experiment shows that, other things being equal, this psychological principle of projection follows the law governing the projection of pictures upon a screen. Place a small disc of green paper, say one inch in diameter, upon a neutral background at your customary reading distance and look steadily at the disc until you obtain a good after-sensation from it. Cover the green disc with a large sheet of gray paper and gaze at the latter without changing the distance between it and your eyes—you will get a red

after-sensation, projected upon the neutral background, which will correspond in shape and size to the green stimulus paper. Then look at some point on the wall, ten or more feet away: you will again see the disc-shaped, red after-image, but this time it will be much larger than the one previously obtained. If you continue with this experiment, varying the distance between your eyes and the background, and measuring in each case both the distance and the size of the projected after-image, you will discover that an old law of physics applies to your results: in the absence of disturbing factors, the area of the after-image varies according to the square of the distance at which it is projected. This same principle, in fact, applies to the apparent size of an object which is seen. For example, it holds when you measure the changes in the apparent size of a building which you are approaching. If we project the two diverging lines extending to Arrow A in Figure 10, and draw additional arrows at successive distances between these extended lines, we will have a diagram to illustrate the principle of visual projection. One factor responsible for the perception of size and distance is thus to be found in the mechanics of the visual organ. It would be strange indeed if the structure of any sense organ did not determine in part the nature of the experience mediated by that organ.

Auditory Localization. We have commented on the difficulty experienced by the blindfolded subject in pointing to the source of a sound produced near him. If this source is somewhere in the median plane of his head, he may guess it to be in front of him, back of him, or perhaps above or below his head. He is much more successful when the sound comes from his right or from his left. Differences in the *intensity* of the stimuli affecting the two ears were once supposed to explain this result: a sound coming from the right is more intense for the right ear than for the left. Recent investigations tend to show, however, that sound localization depends upon the minute difference in time between the reception of the stimulus by one ear and by the other.

When conditions permit, a second factor is involved in auditory localization; namely, tonal complexity. In discussing the auditory sense, we called attention to the overtones which usually accompany tonal sensations. Since overtones (or partials, as they are called) are considerably weaker than fundamental tones, they tend to disappear in traversing long distances. To quote from Carr, "A locomotive whistle in the far distance is hollow, flat, and sonorous because of the absence of overtones. When near at hand, the sound is shrill, harsh, rough, and piercing on account of the presence of high and dissonant partials." [1]

Tactual Space Perception. It is important to distinguish between active and passive touch because the former involves movements with their accompanying kinesthetic experiences. When a blindfolded person grasps a ball, he immediately perceives it to be a round object. His experience is not exclusively tactual, since he obviously benefits by the kinesthetic stimulations aroused by the exploratory movements of his hand and fingers. Nor is kinesthesis eliminated when he receives the ball in his cupped hand and correctly perceives its shape, without exploring it. In this instance, his kinesthetic sensations of strain are blended with his tactual sensations. Finally, if a ball touches some part of his body, he will not perceive its shape unless it presses upon his skin and muscles enough to produce muscular sensitivity. It is questionable, in short, if cutaneous sensitivity without kinesthetic aid can give us tri-dimensional space.

So far as psychologists know, kinesthetic sensations are not involved in one's ability to locate points of stimulation which he did not see. When the blindfolded subject, for instance, is stimulated on the back of his hand, his error in locating this point after the blindfold has been removed usually does not exceed one inch. It is generally assumed, in explanation of

[1] *Op. cit.*, pp. 143-144.

this ability, that each point or small area of the skin has a distinctive local quality, known as a *local sign;* in other words, each point has its own distinctive "feel." Other kinds of sensory experience, such as retinal sensitivity, are also supposed to have local signs. This explanation, however, is unsatisfactory because it expresses nothing more than an introspective fact.

Another type of experiment dealing with passive touch is concerned with the two-point threshold. This was investigated by the German physiologist Weber nearly a century ago. The subject is asked to distinguish between one-point and two-point stimulation when the points are close together; he is tested by an instrument, resembling a drawing compass, known as an *esthesiometer.* Weber found that the two-point threshold, or the ability to distinguish two points, varies for different parts of the body: the tip of the tongue, the finger tips, and the lips are the most sensitive in this respect, while the back, the thigh, and the upper arm are the least sensitive. On the tip of the tongue, two points one millimeter apart are perceived as two; on the back, they may be separated by a distance of over 50 millimeters without being perceived as two points. Although these discriminations are made by the inactive subject, it is significant that the most sensitive parts of his body are those which he uses for exploring and manipulating objects.

The Perception of Time. Our "sense" of time is subjective and personal. The tea which our mother is giving for her friends seems to last forever, while at the dance which honors our high school graduation, the last note seems to come close upon the grand march. Curiously enough, these differences in the apparent duration of temporal units become interchanged when viewed afterwards. James (4) states that, "In general, a time filled with varied and interesting experiences seems short in passing, but long as we look back. On the other hand, a

tract of time empty of experiences seems long in passing, but in retrospect short." [1]

The explanation is a subjective one. During periods of pleasurable stimulation, when one event follows another in rapid succession, we are too engrossed with the happenings themselves to be conscious of their temporal aspects. Afterwards, we mentally review these events at our leisure; we expatiate on them, rehearse them over and over, and perhaps without knowing it add some imaginary details; in fact, we may spend two hours in describing the occurrences of a half hour period. It is no wonder, then, that occupied time is long in retrospection. But try to describe an empty or monotonous evening and the situation is different: since nothing happened, there is nothing to dwell on or to talk about. We cannot describe a blank.

Consciousness of temporal sequences is also derived from exteroceptive stimulation. This would follow from the fact that movement involves time. Thus, we make finer discriminations among units of time while watching an automobile race or a parade than while contemplating the beauty of a mountain range. It is usually held that awareness of time is especially inherent in auditory stimulation. Doubtless hearing does exceed the other exteroceptive senses in this respect, for meaningful sounds, such as the elements of a melody, necessarily appear in temporal succession. Frequently, however, this is true of visual and of tactual stimulation. Both a deaf-mute who is an expert lip-reader and a normal person go to a cinema: whether the picture seems long or short to them depends upon their respective interests in it rather than differences in their receptorial equipment. In this situation, one is probably as good a judge of time as the other.

Psychologists have measured the scope of the "present," or the duration of time indicated by the word "now," in terms of the fluctuation of attention. Look at a simple and unchang-

[1] *Op. cit.*, p. 283.

ing object, a pin-head for example, with the determination to think about it and nothing else, and one of two things will happen: you may fall into a mild trance state, or brown study, which is nothing more or less than the beginning stage of hypnosis, or more likely after a few seconds, you will realize that your thoughts have gone wool-gathering. In the latter event, continue with the experiment for ten minutes and the same results will obtain: your attention will fluctuate every few seconds, despite your best efforts to keep it on the stimulus. This fluctuation likewise characterizes all instances of normal concentrated attention. When you are completely lost or absorbed in a mystery yarn, for example, surely your thoughts are not at a standstill; for concentration of attention over a period of time always involves a succession of ideas or of perceptual experiences. In fact, the greater the concentration, the more rapid is the succession. Using a more elaborate technique than that just described, various psychologists have estimated the maximum scope of the present to be from six seconds to two or three minutes. Whatever the exact duration may be, the significant fact is that time passes because attention fluctuates.

The Nature of the Perceptual Process

The psychologist studies the perceptual process by creating illusory perceptual experiences and thus duplicating, in his laboratory, the conditions under which we are made aware of the external world. His use of the stereoscope and his experiments in sound localization illustrate this procedure. He controls the perceptual experience by altering the factors responsible for it.

The cinema theater is an excellent demonstrational laboratory for the analysis of perceptual experiences. It entertains the public by creating perceptual illusions. Its projection apparatus throws shadows upon a screen, in much the same way that the sun casts shadows of passing clouds upon a meadow.

Of course, the screen shadows do not move: they appear only when the film, containing the "clouds," is motionless. A revolving metal sector in the projection machine shuts off all illumination between exposures, or during the time that the film is in motion; otherwise, we would see nothing more than a meaningless, gray blur. Usually the static pictures or "stills" are flashed upon the screen at the standard rate of 24 per second. The gaps, or periods of no illumination, are filled in partly by our mental processes. We have already noted that a mental factor prompts us to ignore the blind spot and the double images of normal, binocular vision; similarly, as in the case of a "moving" electric sign, we tend to perceive motion whenever successive retinal points are stimulated. Our positive after-sensations also contribute to our experience of continuous motion, for each actual exposure has its visual lag, or positive after-image.

Now the shadows are perceived as objects and situations, and the accompanying sounds are correspondingly meaningful. We localize the sounds where our past experience tells us that they should be localized; for example, when George Arliss talks, the sounds issue from his lips and not from the "horn," located back of the screen. In a modern theater, the screen is perforated and the sounds are discharged equally through all of the perforations; yet when two people, standing a foot apart, talk to each other, we localize each voice at its appropriate position on the screen. Talking pictures accomplish what the ventriloquist of vaudeville days tried none too successfully to do. And as every one knows, this illusion of auditory localization is not dispelled by our knowledge of the mechanics involved in its creation. Even when sight and sound are imperfectly synchronized, the voices continue to come from the lips.

Meaning in Perception. The two factors involved in the perceptual experience are sensory stimulation and its meaning. All sensations have meaning, but the meaning aroused by the

same group of physical stimuli varies from one person to another and from one period of time to another in a given individual. Tradition has it that one President of the United States could recognize only one tune—the national anthem. Allowing for the possibility of exaggeration in this instance, it is nevertheless true that two persons may attend the same concert, receive the same auditory stimuli, and yet have two different auditory experiences. Whether or not they experience the same "sensations" is problematical. Since a sensation is experienced because it is attended to and since attention in turn is partly determined by individual experience, the presumption is that they do not. Striking illustrations of individual differences in perceptual response are found in social perceptions. Albert is handsome or positively homely, depending upon the person who observes his features. One juryman can "see" guilt on the face of the defendant while another can tell by looking at him that he is innocent. The perceptual process thus is related to the process of inferring. That the meaning of a sensory stimulation is subject to change in the individual can be verified by everyday experience. One's progress in the acquisition of a foreign language is characterized by his increasing ability to detect meanings in sounds and graphic symbols. Incidentally, this ability may deteriorate through lack of practice and other causes. Several years after our graduation from college, we happen on our old copy of *Les Misérables,* only to find that it is now meaningless. Occasionally a sensory stimulation may carry two meanings, one as legitimate as the other. Figure 13 is either concave or convex; or, with some effort on our part, flat. Notice that it cannot be concave and convex at the same time, and observe, too, that neither its concavity nor its convexity can be maintained for more than a few seconds. Such geometrical diagrams are called *ambiguous* or *equivocal* figures.

To some extent, we may dissociate meaning and sensory stimulation. When an art critic turns a painting upside down,

he eliminates much of its meaning and he is enabled, as the result, to study its coloring. Similarly, the colors of a sunset become more vivid when one views them with his head in an inverted position. We are so accustomed, in fact, to reacting to meanings at the expense of sensory elements in perceptual

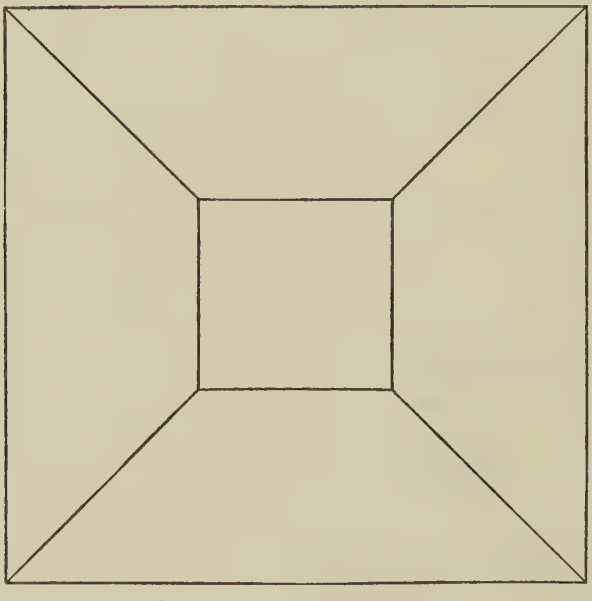


FIG. 13.—Equivocal figure.

experiences that the latter disclose new aspects upon being examined. If you will look at some common word, "precisely" for example, paying particular attention to its typographical features and ignoring its meaning, you will soon find yourself staring at an unfamiliar word. You can also scrutinize the face of your best friend until you find yourself staring at a stranger. In general, the sensory component of a perceptual stimulus serves merely to touch off the overt response or the meaning. It may be considerably reduced in intensity or ex-

tensity and yet continue to serve this purpose. Thus, where the classical artists laboriously painted details, modern painters employ broad lines and colors to accomplish the same result.

An illusion is a *false* perception. We experience an illusion when we perceive a paper snake as a real one, or when we mistake the back-firing of a car for pistol shots, or when we think that an insect is to blame for a cutaneous sensation actually caused by a feather or a straw. An illusion may continue to be such, even after its nature has been ascertained. The stereoscopic effect is an illusion despite the fact that we can analyze and explain it. It was once supposed that *hallucination* differed from illusion in lacking a sensory basis—one who heard voices in the absence of auditory stimuli was the victim of an hallucination. But as many psychologists have suggested, mild forms of sensory stimulation may be involved in all hallucinatory experiences. A characteristic result of prolonged indulgence in cocain is the "cocain bug," an imaginary insect which burrows its way around just beneath the skin surface. Although classified as an hallucination, this experience is caused presumably by a physical irritation of the sensory nerves or of the sensory part of the spinal cord. It is likewise argued that the snakes or other animals which the victim of *delirium tremens* plucks from his clothing are actually small particles of dust. Assuming this theory of hallucination to be sound, it follows that perception, illusion, and hallucination are all forms of the perceptual process.

Meaning and Mental Images. When we pick up a cat, we experience sensations through some of our sense organs. We see the animal, hear it purr, derive some knowledge of its weight through our kinesthetic receptors, touch its hair, and perhaps we get scratched. In part, the cat represents an organization of sensations.

Part of our perceptual experience, however, does not involve the actual stimulation of our sense organs. Upon merely

looking at the animal, we get the "feel" of its fur, and similarly, we get the "feel" of its weight when we see it jump on a chair. Inanimate objects affect us in the same way. We see a cake of ice and perceive that it is cold and heavy.

It was once supposed that meanings were acquired through sensory experience, retained in the form of mental images, and associated with sensations. According to this theory, a perception consists of sensations plus mental images.

Mental images are reported by so many trained psychologists that there can be no doubt about their existence. Described introspectively, they are copies or mental reproductions of sensory experiences. In theory, there are as many kinds of mental images as there are classes of sensations; hence, psychologists speak of visual mental images, auditory mental images, tactual mental images, etc.

But it does not follow that they are necessarily involved in perception. Apparently we may look at a cat and know what it is without having the mental images described above. We can certainly understand the meaning of the printed word "cat," without having a mental picture of a cat. Similarly, when we meet our friend Jones on the street, we recognize him instantly; the recognition comes, in fact, before we have time to recall previous contacts with him. We shall see presently that Gestalt psychologists make this same point. We can say, at best, that the perception of a familiar object *tends* to arouse imagery of that object.

And many psychologists are by no means certain that images are what they appear to be—that is, mental *copies* of sensory experiences. It is possible that they may prove to be sensory experiences. This hypothesis is particularly applicable to kinesthetic sensations. As Angell states the case, "Some psychologists doubt whether kinesthetic images are ever experienced, because they believe that every attempt to secure them results in the contraction, slight though it may be, of the

corresponding muscles, thus arousing kinesthetic *sensation.*" [1] This also seems to be true of interoceptive mental images. When we try to imagine what it feels like to be nauseated, we actually tend to be so. There is some justification for surmising that visual mental images are accompanied by retinal activity. This might be explained by the claim that the optic nerve contains efferent neurons.

In his *Behaviorism,* Watson states that so-called visual mental images are correlated with eye movements or tracings. He intimates that innervations of the exterior muscles of the eye are responsible for alleged visual mental images. Such considerations point to the conclusion that there can be no mental imagery without physiological activity in the sense organs.

The Gestalt Theory of Perception. We stated in the previous chapter that Gestalt psychology is essentially a protest against an atomistic conception of mind. It holds that a perception does not consist of separate and distinct sensations, and separate and distinct images, which have been combined according to the laws of association or the principle of conditioning. On the contrary, as we observed earlier in the present chapter, there is in Gestalt psychology no mental experience more elementary than the perceptual experience.

The Gestaltist's attitude towards personality analysis will serve to illustrate his theory of perception. Usually, the psychologist describes a personality by analyzing it into its component parts. An individual possesses certain traits and certain physical characteristics; each of his traits can be measured, or at least described quantitatively, and each of these physical characteristics is more or less pronounced. Henry Smith, for example, is far above average in intelligence; he is extremely conscientious; he is somewhat timid; he prefers poetry to outdoor sports; he is tall, has small brown eyes and curly black hair, and he is slightly stooped. We could go on

[1] *Op. cit.,* p. 153.

indefinitely in this manner, describing Henry's traits and features one by one and indicating the amount of each that he possesses. But would this inventory of his traits constitute a description of his personality? The answer of the Gestalt psychologist is an emphatic negative. No inventory or enumeration of traits gives a picture of the personality;

FIG. 14.—Reversible perspective. (From Wheeler, *op. cit.*, after Rubin.)

rather, the personality is an organization or a pattern of traits, and each trait must be considered with reference to its background of other traits. Henry's timidity is his own, individual timidity, and it can scarcely be compared with the timidity of any one else. Moreover, if we could remove any one of his traits, we should alter his entire personality. He would no longer be the same Henry.

Similarly, Gestalt psychology insists that perceptual experiences are unitary and meaningful wholes. In perceiving two parallel lines, we are immediately made aware of their relationship to each other; erase either one and the pattern disappears. The pattern does not consist of line one *plus* line

two; in other words, it is not a sum of two lines. Again, in perceiving a triangle, we perceive the *triangle,* and not three unrelated lines.

To the extent that a perception can be said to consist of units, according to Gestalt psychology, it involves a "figure" and a "ground." In terms of traditional psychology, the figure is that part of the pattern which is attended to; it stands out from the ground. A word, written on a blackboard, is a figure,

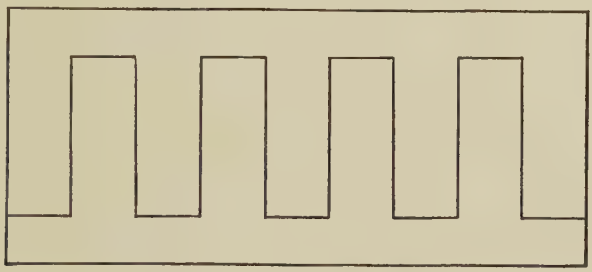


Fig. 15.—Reversible perspective.

while the blackboard is the ground. Of course the ground is an essential feature of the perception. In some instances, figure and ground are reversible. Rubin's familiar illustration (Figure 14) shows both a white vase on a black background, and two human faces in black silhouette on a white background. A more simple example of reversible figure and ground is given in Figure 15.

When two vertical parallel bands on a screen are alternately illuminated at the appropriate speed, one who observes them may see a light which moves from the position of one band to the position of the other. The light jumps back and forth. If the rate of alternation is sufficiently rapid, he will see the two stationary bands simultaneously; if the rate is considerably slowed down, he will see first the one band and then the other in their true positions. Similar effects are produced when the two bands form an "L." This illusion of apparent

movement is called the *phi-phenomenon.* It is demonstrated to a certain extent by ordinary traffic lights: when the green light disappears, it seems to jump down to the middle disc, and incidentally change to amber.

Gestalt psychologists contend that this illusion cannot be explained in terms of eye movements, for it persists when the eye is in steady fixation; nor is the effect an inference, for, like most perceptual illusions, it is independent of a knowledge of the conditions under which it is produced. They conclude that its explanation lies, not in the eye, but in a brain which is so constituted as to permit the perception of motion. Their theory of brain activity is too complex to be discussed here; suffice it to say that in their opinion the brain functions as a whole.

Motor Factors in Perception. It may be difficult to believe that our perceptual experiences are determined by our motor activities; this seems the equivalent of saying that we see and hear and in general perceive things with our muscles. Yet some psychologists, notably Langfeld and Washburn, sponsor this, the *motor* theory of consciousness. To the extent that they are correct, our visual-motor integrations determine what we see, and our auditory-motor mechanisms determine what we hear; so it is with our other modes of sensory-motor behavior. Whether or not they are entirely correct need not concern us; they have at least demonstrated the existence of motor factors in perception.

It will be recalled that Stratton wore an optical device which inverted his field of vision, with the result that he was forced to reconstruct his motor habits. The new coördinations did not interfere with his normal ones; after he had become habituated to the device, he had no difficulty in shifting from one set of habits to the other. For our present purpose, interest in this experiment centers on the fact that, according to his introspective testimony, the usual and the inverted

visual fields seemed equally normal when the new habits became fully established. In other words, Stratton ceased to be conscious of the difference between the two.

Philosophers once wondered whether a man who had vision for the first time upon reaching maturity would recognize a triangle through his newly-acquired sense. Surgical technique has since made it possible to give an answer. A man who is thus given his sight has to *learn* to see. He cannot recognize a triangle, and until his contact or auditory sense is applied, he cannot distinguish between a triangle and a dog through vision alone. In one case, the patient reported that for some time following his operation, everything he saw seemed to be plastered upon his retina: visual depth perception was entirely lacking. He acquired visual depth perception by walking towards and touching objects. It is quite conceivable that one of his first acts was to reach for the moon. Needless to say, the objects themselves were as unfamiliar as their spatial relationships.

When we look at a number of concentric circles, drawn alternately in red and in green, the red circles seem distinctly to stand out from the green ones. A similar effect is produced by a red and a green light at night: the red seems nearer to the observer, even when he knows that the two are equidistant from him. Now red light is more difficult to refract than is green. Consequently, the lens of the eye thickens and its surfaces become more convex when red light is passing through it; conversely, it becomes thinner when it accommodates for green. The lens also thickens when one looks at a near object and flattens when one gazes into the distance. The lens, therefore, assumes one shape in accommodating for red light and for near objects, and another in accommodating for green light and for far objects. Apparently, red has become associated with nearness through the functioning of the accommodatory mechanism; yet we get these visual effects without being conscious of their motor cause. Under normal conditions, we

cannot by the closest attention detect kinesthetic sensations from the ciliary muscle.

Langfeld (5) reports an investigation in which he and Car-

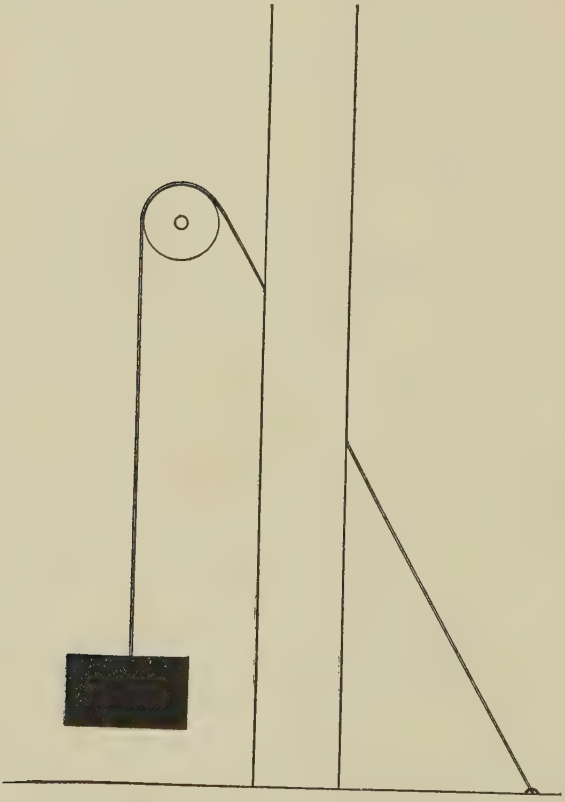


FIG. 16.—Poggendorff illusion in a setting which tends to reduce the illusion.

michael succeeded in decreasing the magnitude of a visual illusion by introducing the suggestion of a motor element. You may test this for yourself. Cover both the right and the left parts of Figure 16 by cardboards, so that you will see

a diagonal line to the right and to the left of the two parallel lines. This is the familiar Poggendorff illusion: although the two parts of the diagonal line belong to the same straight line, the part to the right of the parallel lines looks displaced. It seems to be drawn too low. Remove the cardboards and look at the entire figure. The diagonal line is now a rope which passes over a pulley and which suspends the heavy weight. When the figure is given this meaning, the magnitude of the illusion is reduced. We somehow get the muscular feel of the rope with its attached weight; we perceive that the rope is taut and therefore straight.[1]

Margaret F. Washburn (9) has advanced a motor explanation of certain illusions of size. In the upper part of Figure 17, circle A looks larger than circle B although they are of the same size; in the lower part of the figure, the inside circle of C looks larger than the outside circle of D although the two are the same. Miss Washburn grants the possibility that A seems larger than B because it is compared with the smaller circles surrounding it, while B seems smaller because it is compared with the near-by, larger circles. Also, the inside circle of C looks larger because it is assimilated with the circle around it, while the outside circle of D is assimilated with its enclosed circle. But in addition, circles A and B ". . . are so placed that *it would be easy to pick them separately*. They are therefore perceived as separate things and compared with one another. On the other hand, in C and D, . . . the concentric circles are so placed that one would naturally pick them together. They look, in fact, much like a plate. Hence it is that they are perceived as a single thing, and not being compared with each other, the consciousness of their difference is lessened."

Evidence that auditory-motor integrations play a rôle in auditory localization has been furnished by Young (10). This

[1] The diagram used by Langfeld and Carmichael, *op. cit.*, shows two men pulling the rope taut.

psychologist obtained results in auditory space comparable with Stratton's findings in visual space perception. He used

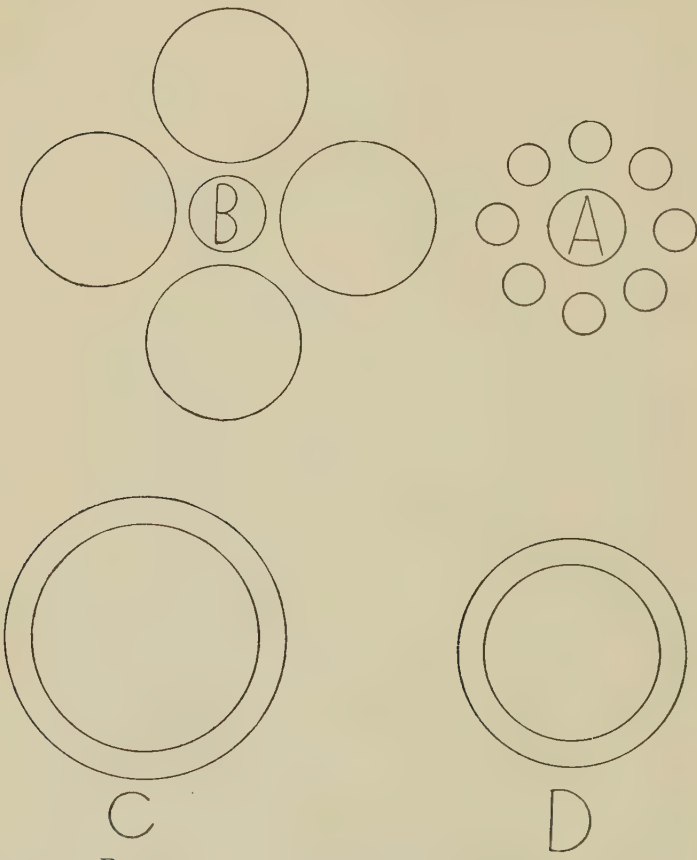


Fig. 17.—Illusions of size. (After Washburn.)

a *pseudophone,* a device consisting of two ear trumpets, fastened close to his head near his ears; but the sound received from the right was conducted to his left ear by a tube extending over his head, while in similar fashion, the sound received

from the left was conducted into his right ear. This device was worn during a period of 18 days. As one would guess, Young's auditory-motor responses were at first seriously disturbed. He reports, for example, that when he heard a dog barking on his left, he naturally turned his head towards the left; but of course, he did not see the animal until he turned his head in a direction which seemed to be away from it. Like Stratton, he established new and effective sensory-motor coördinations. Then, according to his report, "In a great many cases, the reversed localization changed to normal when the position of the source [that is, the source of the sound] became known." That is to say, he actually heard the sound *at his right,* in spite of the fact that the sound was being conducted into his left ear. Young concluded that the essential condition for sound localization is a neuromuscular set or attitude.

Conclusion. In all likelihood, each of the theories discussed above correctly names certain factors in the perceptual process. A perceptual response involves (a) the sensory stimulation, (b) integrative activity in the central nervous system, and presumably (c) the motor response. Both psychologists who believe that imagery plays a rôle in perception and Gestalt psychologists stress the function of the central nervous system in perception; Langfeld and Washburn add an emphasis upon the motor response. The view that perception is a form of sensory-motor integration provides for the essential contentions of all three theories.

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CHAPTER IV

THE MOTIVATION OF BEHAVIOR[1]

The psychology of motivation undertakes to explain *why* the organism acts in a given way on a particular occasion. A few hypothetical illustrations will clarify this statement and relate the general problem of motivation to the problems previously discussed. On being taunted with an insulting remark, a man flares up and strikes his enemy in the face. Two men of equal wealth contribute identical sums of money to a charitable organization, yet we suspect that one gives cheerfully and the other reluctantly. A dog and a cat manifest friendly interest and fear respectively when confronted with another dog. Without apparent cause a circus elephant noted for its amiable disposition suddenly turns savage and morose. An insane patient who refuses to eat palatable food insists, unless restrained, upon swallowing chalk, bits of wood, or even metal objects. Or perhaps a man whose moral conduct has been blameless embezzles money. Motivation is merely the general term that denotes such internal causes of behavior.

Motives Defined as Factors. A few psychologists question the validity of the concept, motive, chiefly on the ground that all so-called motives can be reduced to forms of proprioceptive and interoceptive stimulation, or the physiological states of hunger, fatigue, erotic excitement, emotion, and the like. Furthermore, they urge that "motive" lacks scientific dignity because it is used in popular speech. In their opinion, the

[1] Some of the theoretical considerations discussed in this chapter appeared in an article by the writer in the *Psychological Review,* 1923, 30, 176-191. They are here reproduced by the permission of the editor of the *Review.*

psychology of motivation is merely the psychology of the novelist or playwright, the school-teacher, or perhaps the police officer. This, so they claim, is not scientific psychology.

Fortunately, however, one fundamental conception will free the term motive from its obscurity and justify its use as a scientific term. It is noteworthy that "motive" is used both in animal and in social psychology. This conception fulfills the requirements of both fields of investigation. In Chapter I, we called attention to the motivation of the white rat, as it affects his learning process. When this animal is first placed in a maze, it explores the new environment, provided that it is hungry, thirsty, or otherwise motivated. The rat will tend to eliminate culs-de-sac and to discover short-cuts if such exist. Its behavior is thus determined, in part, by its physiological demands. Notice that the motivation can be *inferred* from the behavior: the ordinary observer, not knowing that the rat had been deprived of food previous to its introduction to the maze, might nevertheless correctly surmise from its behavior that it was hungry.

Similarly, we infer the existence of motives in human beings from their behavior. The desire of the human animal to climb the social ladder is just as truly a psychological fact as its state of hunger; it is just as much a fact of human nature. We witness Mrs. Smith's behavior at the dinner table, on some particular occasion, and infer that she is hungry; we observe her behavior at social functions and conclude that she is socially ambitious. Assuming that she is fairly intelligent and not over-given to rationalizing, we should doubt her honesty if she denied this motivation in either instance.

A motive, then, *is a factor or a group of factors which operates within the organism (or the human personality) in such a way as to determine in part its behavior.* Defined in this way, a motive may be a headache, a state of indigestion, a personal grudge, or an interest in the drama. Each of these functions within the human being or the personality more or

less independently of fluctuations in his social environment; each has some demonstrable effect upon his overt behavior.

Nor is it altogether absurd to classify such an assortment of "physical" and "mental" factors under the heading, motive. It is frequently asserted, for example, that indigestion and pessimism affect overt behavior in much the same way; it is even claimed that the former is the cause of the latter. Typically, physiological and social or mental factors are so closely associated that they cannot be separated. We may call attention to the intimate way in which physiological craving and social pressure so frequently conspire to make men smoke or drink.

Consider an animal motive which has a counterpart in human behavior. As yet no scientist has explained fully why a mule balks. Something which is clearly organismic and which persists in spite of environmental fluctuations underlies this negative behavior. Presumably, a similar internal condition or state occasionally prompts a small child to endure physical punishment rather then eat his breakfast. The mother cannot explain this behavior to her own satisfaction, for her other child, even if he is a twin, may not be so recalcitrant under what apparently are the same provocations. So she calls it "stubbornness." Finally, let us consider the man who because of pique, indigestion, or some other reason known or unknown to himself, likewise sits at the breakfast table and refuses to eat a mouthful. Of the three reacting organisms mentioned, only the last is capable of anything like a self-analysis of motives; but if the concept of rationalization actually expresses a fact of human nature, his introspective account is likely to be untrustworthy. It is reasonable to believe that the motivating factors in the three organisms have something in common; we are sure of their existence but we can only speculate regarding their nature and origin.

The Objective Approach to Motivational Analysis. It is possible for a psychologist or for any student of human

nature not only to infer the existence of a motivating factor in some other human but to measure its strength and duration. To illustrate, consider the practical and scientific problem of isolating some of the factors, including the motivational factors, which underlie scholarship. For one thing, we are forced to conclude that attitudes and interests, as well as intelligence, are instrumental in determining scholastic marks. By all tests designed to measure "intelligence," Sarah proves to be highly endowed with mental ability, yet despite this fact she does poor work in elementary laboratory zoölogy. Her explanation is straight-forward enough: she loves cats and she is emotionally averse to dissecting them; in fact, her affective attachment for them inhibits the development of any possible interest in their anatomy. Now this is a verbal report which, we shall assume, satisfies neither her dean nor the psychologist who is consulted in regard to her "case." Possibly Sarah is either lying or rationalizing. The more charitable hypothesis leads us to suspect, among other possibilities, that while she really dislikes dissecting she is even more disinclined to "waste" hours in any laboratory. It is clear that certain objective data may throw light upon the motive or motives; so the psychologist obtains measurements of her personality traits and compares them with records of scholastic achievements in other courses which she has taken. If he finds that her behavior responses are conditioned largely upon personalities he must entertain a new hypothesis to the effect that her work to some extent reflects a hostile attitude towards her instructor. In other words, he makes legitimate inferences regarding her motivation.

A second example will show that objective motivational analysis is forced upon us in everyday behavior. Suppose that A, from all objective indications an intimate associate of B's, suddenly and for no discernible reason stops speaking to B. Several possible explanations for A's change of attitude occur to us: he has learned that B is dishonest, or that B has been

exploiting him all the while but can no longer "use" him; or he fears that B will discover some of his personal secrets; or perhaps he has become bored with his former companion. Since A refuses to discuss the affair, his motive is a matter of conjecture. The facts as stated might indicate that his altered behavior is an initial symptom of insanity. Even so, this throws little light upon his specific motivation. Something is responsible for A's reversal of conduct; as mutual friends of both would describe the situation, "Something is wrong." A change has taken place in A's observable behavior, and presumably a change of some sort has taken place *in* A. Assuming this to be true, we shall call it a change in his motivation.

It is clear that physiological and social motives function in the same way; they can be measured, as a matter of fact, by the same quantitative methods. A's motive exists in some appreciable amount for it exerts an appreciable and hence an observable effect upon his conduct. It is subject to measurement in a variety of ways. Thus, its duration may be estimated roughly by the number of days, weeks, or months which may elapse before A resumes amicable relationships with B. In this event, we may assume that his motivation has changed again.

Motives and the Behavior Cycle. From the physiological standpoint it is theoretically possible, as Dashiell (13) claims, to explain all motives in terms of the tissue needs of the body.[1] Usually the human animal, as well as the horse, does drink when it is led to water—provided, of course, that its tissues need water. The body of the complex organism is made up of cells which are grouped together to form tissues, organs, and systems; it also consists in part of the chemical substances manufactured by some of its cells. The needs of the individual cell, considered apart from its relationships to other cells or to the various systems or to the body as a whole, can

[1] *Op. cit.,* Chapter IX.

be reduced to the need of maintaining a balance between anabolic and catabolic processes. But the psychologist is not interested primarily in the needs of individual cells; rather, his interest lies in the needs of the organism as a whole. Hence, "tissue needs" should refer to such physiological demands as are directly responsible for the behavior of the organism as a whole. As we pointed out in our discussion of the behavior cycle, such demands result in goal-seeking activity, and their satisfaction results in inactivity.

These demands come largely but not entirely from visceral tissues. It certainly is not true that the completely devisceratated organism would be a non-motivated organism. We are accustomed to thinking of hunger and sex as the basic physiological drives or motives; but tissue needs likewise are manifested when the organism seeks a satisfactory degree of temperature, a comfortable bed, a moderate amount of pressure stimulation, or relief from cutaneous pain. Obviously, all parts of the body have their respective tissue needs.

Just how these primitive, physiological needs become transformed in the human personality into *social* needs is explained later in this chapter. For the present, we may state merely that they are experienced as conscious *desires*.

Drive and Mechanism. An excellent introduction to the study of motivation is furnished by Woodworth's (32) conception of drive and mechanism. The drives of an organism explain *why* it does certain things; its mechanisms explain *how* such acts of behavior are accomplished. To use Woodworth's illustration, the drives of a baseball pitcher account for his interest in the game and the zeal with which he pitches against any particular batter, while his mechanisms are responsible for the skill that he displays. Woodworth also uses the analogy of machinery to explain his distinction. The drive is the motive power—the steam, the electricity, or gas, while the mechanisms of a machine include its gears, levers, and pulleys. It goes without saying that drives and mechanisms

are mutually interdependent, so that any discussion of drives presupposes the existence of mechanisms.

In the present chapter, the terms drive and motive are synonymous. To appreciate the nature of drives we should think of such varied factors in behavior as a toothache, the pain caused by a whipping, hunger, boredom, the craving for cocain, disgust, anger, affection, emotional hypersensitivity, chagrin, jealousy, and delight over a compliment. It will be noticed that these are states of the organism that modify and direct its behavior. Moreover, while some of these states are apparently physiological and others mental or psychological, they are all ultimately physiological in character. The student will find it profitable at this point not to attempt to distinguish too closely between physiological and psychological phenomena.

Emotions and Motives. Emotions constitute one important group of motivating factors shared in common by man and beast. The *physiological* drives discussed in this chapter likewise characterize both human and animal behavior. The higher organisms behave as they do because they are equipped with the physiological mechanisms for fear, anger, sexual love, hunger, pain, and the like. On the other hand, man is far removed psychologically from the ape, his nearest prototype. As the following considerations show, the distinctive features of his psychological composition are nowhere more clearly reflected than in his motives.

Two Groups of Factors in Human Motivation. There is no denying the fact that man is a creature of flesh and blood. This fact has been sufficiently stressed, but upon analysis human motives are found to be highly intellectualized and socialized. Since the term *socialization* really involves the process of intellectualization, it can be used conveniently to designate both processes. This enables us to describe two groups of factors in human motivation; namely, the physio-

logical and the social. Both groups are found in practically all motives.

By way of illustration we may consider the hunger drive. At the first glance nothing would seem further removed from psychological interest than the activities involved in securing and preparing food. The topic seems to belong to physiology and economics rather than psychology; and at best the pleasure of eating would seem to be "purely physical." The truth of the matter is, however, that a surprisingly large part of human conduct is motivated by the hunger drive. Moreover, it is a highly socialized function. For the majority of people, a meal eaten in solitude is a dismal affair.

The conditioning process described in Chapter II operates in two different directions in assimilative functions: digestive reflexes become conditioned upon stimuli associated with eating, and esthetic responses seem to be derived in part from the satisfaction of food desires. It is generally recognized that immaculate linen, shining silver, flowers, music, and agreeable conversation are conducive to good digestion. We have sound experimental evidence for believing that these factors act as conditioned stimuli for gastric movements and secretions. Conversely, the pleasures of eating become attached by the conditioning process to extraneous objects and situations. According to tradition, the wife should broach the delicate question of buying an expensive fur to her husband just after she has given him a satisfying meal. Perhaps on strictly logical grounds few things are more disgusting than the act of masticating and swallowing food, but so intense is the resulting enjoyment that "good taste" has become synonymous with esthetic appreciation. It seems clear that the conditioned responses associated with the hunger drive are responsible for the degree of socialization attained by this drive.

In a very significant way the activities involved in securing and preparing food are intellectualized. People *think* about good things to eat; intelligent and cultured people indulge

without shame in pleasurable anticipations of hunger satisfaction. Both the dog and the human enjoy their meal; but unlike the animal, the human being *remembers* his last meal and *plans* the next one. It seems generally true that in the development of the race the chief function of intelligence is to provide for the fundamental biological needs.

The sex drive in human beings affords a still better example of the socialization of motives. Since sex functions provide for the race rather than the individual, they are of necessity regulated by society. In this respect they present an interesting contrast to the food drive: for instance, even though gluttony is personally disgusting, it is scarcely to be thought of as immoral. Sex motives have been socialized and regulated to the extent that their physiological basis is frequently not introspectively recognizable; that is, people often refuse to acknowledge sex motives when these motives actually dominate their behavior. The Freudians, a school of psychologists named after its leader, Sigmund Freud, have used the term *repression* to designate extreme cases where individuals, from idealistic reasons, flatly and indignantly disavow sex motives unmistakably responsible for their conduct. The extent to which sex drives enter into human behavior may be surmised from the perennial interest in love themes manifested by the normal run of human beings. From poetry to moving pictures all forms of art attest to this fact.

The process of socialization has been carried so far that some of the most powerful human motives apparently have lost their biological affiliations. This fact requires explanation. It is easy to see how physiological drives in human beings become ends in themselves, since they originate in known anatomical mechanisms. Just why, however, should people be so greatly concerned over the various forms of social recognition? As a matter of pure enjoyment, the average man might prefer a compliment on his good looks to an excellent meal, although he possesses no elaborate system of organs for

the former as he does for the latter. So far as we know, the various forms of social motivation, centering around the fundamental *prestige* motive, are practically unknown in animal behavior. But since they are derived from the basic physiological drives, their analysis must be deferred until these drives are given more consideration.

Rationalization. The process whereby human physiological drives have become intellectualized and socialized has produced one curious human trait. We have already pointed out that human beings often refuse to acknowledge their sex drives. As a matter of fact, however, they refuse to acknowledge many of their motives, and prefer to endow themselves with purely fictitious ones. This process is called *rationalization.* Examples of this trait are not far to seek: it is found in all of us. People are notorious for finding reasons why they should do agreeable things, and why they should postpone disagreeable tasks. No sooner does the student sit down to the irksome task of translating a Latin assignment than he thinks of the letter that must be written home without delay. Again, we excuse faults in people we like, and criticize these same faults in those not so favored. Another way in which we rationalize our motives is to substitute righteous indignation for what is actually jealousy or envy. As the term suggests, rationalization is one form of the process of intellectualizing motives. In most instances, the physiological drives and the basic emotions are the motives which are rationalized.

Physiological Drives

The foregoing considerations suggest that the psychology of motivation should start with physiological mechanisms and then proceed to the more purely social factors involved. The physiological mechanisms concerned are by no means limited to the digestive and reproductive systems. Man requires moderate degrees of thermal stimulation, comfortable physical surroundings, opportunity for physical exercise, health; and by

virtue of his capacity to acquire tastes he frequently demands narcotics and stimulants. His intellectual and social activity is largely devoted to the satisfaction of his physiological drives.

The Autonomic Functions and the Personality. Perhaps the most complete theoretical explanation of what we have designated as physiological drives is found in E. J. Kempf's (18) analysis of autonomic functions as related to human personality. According to Kempf, the behavior of human beings and the higher animals is *motivated* by the autonomic nervous system and *executed* by the cerebrospinal. This means that the former system is responsible for the "why" of behavior and the latter system for the "how." The cerebrospinal nervous system, therefore, is subordinate to the autonomic. Through its system of exteroceptors, it guides the organism about in the environment in a way physiologically satisfactory to the autonomic system. While Kempf does not employ the term, he regards drives as states of tension in the autonomic system that demand relief. In any one case the desired relief can be obtained by presenting the appropriate stimuli to, or by eliminating unwelcome stimuli from, the exteroceptors. In brief, the cerebrospinal system moves the exteroceptors in the environment for the purpose of adjusting stimuli to the needs of the autonomic system. In practice, of course, the entire organism moves in the environment, but it moves with reference to the needs of the autonomic system.

The facts upon which Kempf bases his conclusion are rather well known. Hunger is a craving caused by certain characteristic contractions of the stomach. This craving is relieved when the appropriate food stimuli are placed in contact with taste receptors, provided that the food is subsequently swallowed and digested. If, however, no food is available, the exteroceptors are required to do scout duty until it is found. The organism moves about until its visual, olfactory, and even auditory receptors locate the desired food objects. In much the same way, sex cravings caused by glandular activities and

smooth muscle contractions prompt the mating activities of animals and the courtship of man. In the cases just mentioned the cravings are caused by visceral stimuli, but in other cases, as when a human being smells putrid meat, the stimuli are somatic. But the reaction involved, namely, the state of nausea or disgust, is, like hunger, a change in the tonicity of visceral muscles. In the majority of situations visceral and somatic stimuli combine, either to arouse or to satisfy a craving.

Kempf's theory is hedonistic in that he practically regards pleasantness and unpleasantness as the determining factors in motivation. Unpleasantness is due to, or identified with, a spastic, tonic condition of a given smooth muscle segment—that is, a condition of marked contraction in which some position of a visceral muscle is maintained more or less spasmodically. Pleasantness results when the muscle returns to its state of normal contraction or tension. The nerve impulses generated by the visceral condition associated with unpleasantness and demanding relief, discharge into and control the cerebrospinal neurons, and the organism acts accordingly. According to Kempf's theory, a hypothetical organism, either animal or human, that is completely deviscerated would be utterly lacking in motives and consequently incapable of moving about. It would have no emotional life, no capacity for experiencing pleasantness or unpleasantness.

In viewing emotions as autonomic or visceral tensions, Kempf again is merely emphasizing a general view that long antedates his theory. But Kempf's definitions of the specific emotions in terms of his theory are somewhat unique. Each emotion he defines functionally, with reference to the stimulus-response situation that affects the autonomic system. The fear response tends or attempts to remove the exteroceptor from a painful stimulus. It is, therefore, a withdrawing reaction that relieves an unpleasant condition of the visceral muscles by getting away from the stimulus responsible for

this condition. The proverbial ostrich complies with the letter if not the spirit of Kempf's definition of fear behavior. In contrast to fear, anger tends to remove a painful stimulus from the receptor. In the case of the small boy who, bent on stealing a watermelon, invades a field only to be discovered and chased out in a state of terror by its irate owner, we find excellent illustrations of Kempf's definitions. According to his theory, sorrow or grief is a form of fear due to the loss of a pleasure-giving stimulus. Joy is a pleasant state caused by the disappearance of a potential pain-stimulus or the acquisition of a pleasure-stimulus. Kempf furthermore states that certain emotions are derived from others. Disgust contains elements of fear and anger. Jealousy and envy are even more complex. All emotions necessarily possess a feeling-tone—that is, they are either pleasant or unpleasant.

Experimental Studies of Animal Drives. When we turn from theoretical to experimental literature we find that drives or motives can not only be described but also measured. Two investigations, conducted by Moss and Simmons respectively, will show how the psychologist approaches this problem. Incidentally, although it was necessary for both investigators to subject the animals to painful stimuli, their treatment on the whole was milder than the educational discipline often meted out to children.

(1) Moss (24) based his experiment upon the following thesis: "The behavior of any animal is the resultant of his drives to action and the opposing resistances." In order to measure these factors he devised a box, divided by two partitions into three compartments. The first compartment contained the animals to be tested; the second, which opened from the first, had a floor constructed of metal plates so arranged that they could be charged with varying amounts of electricity; the third, opening in turn from the second, contained the stimuli designated to arouse the drives. In order to go from the first compartment to the third, the animal was forced

to traverse the metal plate and receive a series of electric shocks.

In one series of tests, Moss measured the strength of the hunger drive. After his rats had been "taught" that the plate was painful, four of them were placed in the first compartment and kept there 12 hours without food; but none of them during this period crossed the plate, which was charged with a 20 volt current, in order to secure the tempting food placed in the third compartment. A second group of 4 rats was tested for 24 hours, with the result that one crossed the plate and satisfied his hunger. A third group of 4 was kept for 48 hours, but this time 3 of them crossed. A fourth group of 4 rats was kept for 72 hours, and all of them finally crossed. In a variation of this test, Moss discovered that a 72 hour hunger drive is stronger than a 28 volt resistance. Thus Moss measured the hunger drive in hour quantities in terms of an electrical stimulus graded in volts.

In a second series of tests, Moss measured both sex and maternal drives in female rats. Contrary to popular belief, sex was found to be inferior to hunger in driving force. Still weaker was the maternal drive, for of a group of mother rats placed in the first compartment only one braved the metal plate to reach her squealing offspring on the other side. Moss discovered, however, a considerable amount of individual difference among the animals.

A third series of tests was concerned with relative differences of intensity in the driving forces studied. For one thing, Moss measured the relative efficacy of ice-water compared with the electric shock as a stimulus. He also established permanent conditioned inhibitions for particular kinds of food by associating this food with shocks—in much the same way that a cat is kept by punishment from jumping up on the dinner table. Finally, Moss studied the ancient question of punishment *versus* reward by forcing his rats to learn to escape from an intricate series of pathways. He found that both food and

sex incentives are superior to punishment under the conditions of the experiment.

What Moss did with white rats under controlled conditions is attempted in haphazard fashion by all human beings who attempt to control their fellows. People responsible for the supervision and care of the feeble-minded, the insane, or the inmates of jails and penitentiaries could well afford to study this and similar experiments with the purpose of applying the ideas and suggestions contained to their particular problems. Parents and teachers by so doing would place the management of children on a level at once more scientific and more humane. While scientific psychology is primarily concerned with facts, its applications are in many instances self-evident.

(2) Simmons (27) was interested in the problem of controlling incentives in animal learning. As she points out, the incentive is a factor which has been neglected in most studies of habit formation or learning in animals. One device frequently employed in studies of this sort is the maze, a complicated series of pathways with one true path leading by a devious route from entrance to exit, and with many branching culs-de-sac or blind passages. A diagram of a maze is given in the following chapter of this book. The typical animal maze is constructed of wood, and, when designed for the white rat, its pathways are approximately 4 inches wide and 4 inches high. The length of the pathways varies from several inches to several feet. The animal, moderately hungry, is placed in the entrance and left to discover the food at the exit. As one can readily imagine, its initial behavior consists of random, exploratory movements. It usually finds a way to the food, as the result of its persistence, but it is permitted to eat only a few bites. This performance constitutes one trial. Subsequent trials differ from the first in one important respect—the animal has been given a more definite incentive for learning the maze. And with a sufficient number of trials the animal will "learn" the maze; that is, it will acquire the ability to go

from entrance to exit with no errors. Time and errors are recorded for each trial, so that the experimenter has a quantitative record of the learning process.

In Simmons's experiment groups of white rats learned two mazes under conditions of varying incentives. In order to control the factor of difficulty, one of the mazes was relatively simple and the other decidedly more complex. This enabled the experimenter to ascertain whether results obtained from the easy and from the difficult learning problems were comparable with respect to incentive. The following rewards were used as incentives: bread and milk, sunflower seed, temporary freedom or escape from the maze, return "home" (to the cages), sex attraction and maternal appeal. The bread and milk reward was the standard of comparison. The effect of delaying the bread and milk was also studied.

Simmons found that the various incentives produced distinctive effects upon the learning process. The bread and milk incentive turned out to be the most effective, showing that as far as the conditions of her experiment are concerned, a favorite food is a more effective incentive to learning activity in a white rat than freedom, "home," or sex. Furthermore, the relative effectiveness of the different incentives was constant for the two mazes. The effects of delaying the reward were somewhat contradictory, but on the whole they were relatively insignificant as compared with the kind of incentive used and with the degree to which the impulse aroused by the incentive was satisfied. For instance, complete satisfaction of hunger was more effective than partial satisfaction. An additional result is that the differences among the various incentive groups were more marked for time records than for error records; that is, the time consumed in going through the maze was a more exact indication of the kind of incentive used than the number of errors made in the same trial. With certain incentives, the rats tended to waste time by stopping to scratch themselves and to wash their faces.

The Hunger Drive. In experiments of the kind just described, the chief factors controlled are the external stimuli and the objective responses made by the animal. Our knowledge of physiology enables us to say that these external stimuli exercise specific effects upon certain internal mechanisms, such as the digestive and reproductive systems. These were indirectly controlled in the experiments just summarized. That they can be directly controlled is shown by some experiments which we shall now review.

It is possible to study the inner mechanisms responsible for the specific drives by means of the proper physiological technique. In this way hunger has been studied by Cannon (8), Carlson (9), and Wada (31). The student should not regard studies of this sort as "mere" physiology. It happens that of the three investigators just mentioned, the first two are physiologists and the third a psychologist; but the classifications are inconsequential. Quoting Cannon, Wada states that "on the same plane with pain and the dominant emotions of fear and rage as agencies which determine the action of the organism, is the sensation of hunger." Wada further explains how hunger as a motive is of tremendous interest in history, sociology, and social psychology. It plays an important rôle in explaining why men do what they do, hence it is a factor in human behavior.

The technique employed by both Cannon and Carlson in investigating hunger involved the use of a rubber balloon which was swallowed in a collapsed condition, with a connecting tube leading out of the mouth, and afterwards inflated with air until it filled the cavity of the stomach. The free end of the tube was connected with a recording device, a pointer that made a tracing on smoked paper placed on a revolving drum. By means of this apparatus stomach contractions were registered graphically by fluctuations of the pointer.

Using this apparatus Cannon made the discovery, subsequently verified by Carlson and others, that the conscious

pangs of hunger are accompanied by contractions of the stomach. In fact, all available evidence points to the contractions as the cause of hunger, or as the immediate condition for the arousal of hunger sensations. According to Cannon, these contractions cease after a few days of absolute fasting with the result that the fasting individual then experiences no hunger. Under normal conditions hunger contractions begin three or four hours after eating, and continue at intervals as long as the stomach is empty. Hunger contractions differ from the digestive movements of the stomach. The former start at the cardiac opening of the stomach and spread in peristaltic waves to the pylorus, or the opening from the stomach to the duodenum (the beginning of the small intestine); whereas the digestive contractions begin at about the middle of the stomach and run to the pylorus.

The most extensive investigations of hunger contractions from the psychological standpoint were made by Wada, who used the balloon method. Among the phenomena which occur simultaneously with the contractions are, according to Wada, the flow of saliva, bodily movements during waking and sleeping states, dreaming, increased strength of handgrip, and greater efficiency in mental work. Hunger thus acts as a tonic upon mental activity. Wada also discovered that while hunger rhythms cannot be controlled voluntarily they are inhibited by reading interesting stories, particularly those with an emotional appeal. Other investigations referred to subsequently would seem to corroborate this result.

Cannon reports a variety of experiments concerned with the digestive process that have an important bearing upon psychology. By an operation upon a dog's stomach he produced a gastric fistula, similar to the salivary fistula of Pavlov's dog, mentioned in a previous chapter. This enabled him to measure directly the secretion of gastric juice in the stomach, and to show that the smell or sight of a favorite food will cause this juice to flow. As he says, "The stomach as well as the

mouth waters." But anxiety or embarrassment inhibits both gastric and salivary secretion. In the "ordeal of rice," a practice once prevalent in India, an individual accused of some crime was forced to chew and spit out rice, and if it was dry, the accused was adjudged to be guilty.

That the actual presence of food in the stomach is not a prerequisite for the secretion of gastric juice, Cannon proves by his experiment in "sham" feeding. Animals were operated upon in such a way as to cause food when swallowed to drop to the ground through an opening in the esophagus and thus never reach the stomach at all. In such instances, however, the gastric juice begins to flow after an interval of five minutes and continues after the sham feeding ceases. To all intents and purposes the animals enjoy eating under such circumstances; and they have the advantage of being prepared physically to eat indefinitely.

In another series of experiments with the fluoroscope, the instrument that utilizes the X-ray for purposes of direct examination, Cannon demonstrated the inhibitory effect of unpleasant emotional stimuli upon gastric and intestinal peristalsis. When the food given a cat is rendered opaque to the X-ray by bismuth or barium, the normal peristalsis of the animal can be observed. It is ordinarily continuous; but let a dog be brought into the room near the cat and the peristalsis ceases abruptly. All of Cannon's studies of hunger show how intimately this physiological function is associated with psychological activities.

Drives, Adrenin, and the Autonomic Nervous System. Kempf and others have definitely explained drives in terms of visceral tensions and endocrinal activities, but few investigators have attempted to ascertain the exact rôle of the autonomic nervous system in behavior. This is another way of saying, of course, that the physiology of the autonomic nervous system is little understood. Of the views concerning this system that have been advanced, Cannon's is perhaps the best

known and (provisionally) the most generally accepted. It at least possesses the merit of being based upon experimental evidence.

In calling attention to Cannon's view of the autonomic sys-

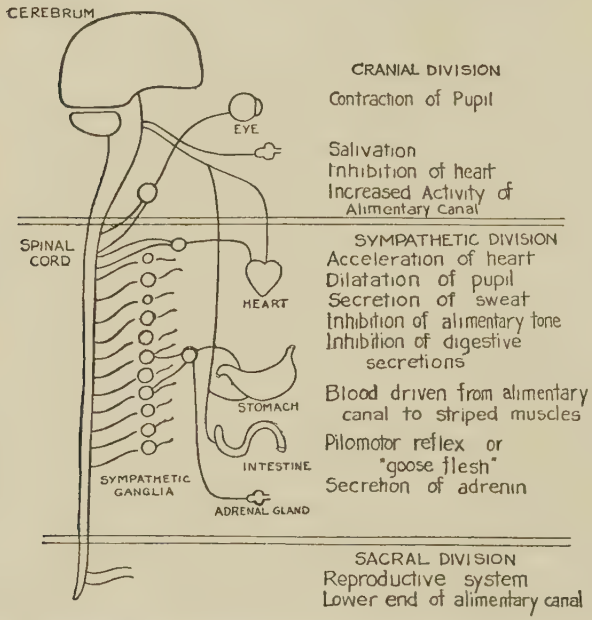

FIG. 18.—Diagram showing the divisions and presumed functions of the autonomic nervous system. (Modified from Cannon.)

tem, it is necessary to note certain anatomical details of this system not yet mentioned. The sympathetic nervous system is that part of the autonomic which consists of the chain of ganglia near and parallel to the thoracolumbar portions of the spinal cord. In addition to the sympathetic, the autonomic system includes (1) the cranial ganglia, located in the head, and (2) the sacral ganglia, located near the base of the vertebræ. Anatomically, therefore, the sympathetic nervous sys-

tem is interpolated between the cranial and the sacral divisions of the autonomic. Figure 18 indicates these divisions and their functions.

On the basis of function, the cranial and the sacral segments taken together are distinguished from the sympathetic, for reasons that will appear presently. In brief, the sympathetic segment dilates the pupil of the eye, accelerates the heart, inhibits the activity of the alimentary canal, inhibits digestive secretions, reduces the flow of the blood in the alimentary canal, causes pallor and "goose-flesh," excretes sweat, and secretes adrenin. As opposed to this group of activities, the cranio-sacral segments of the autonomic retard heart action, contract the pupils, accentuate salivation, increase the activity of the alimentary canal, provide for the excretory functions of the digestive system, and, in part, innervate the reproductive organs. Experimental evidence shows, according to Cannon, that the two sets of functions just enumerated are definitely associated with the two divisions of the autonomic system.

This functional distinction can best be understood by noting that the sympathetic activities considered as a whole show the organism in a state of physical and emotional excitement, whereas the cranio-sacral functions picture the organism in a state of vegetative tranquillity. The sympathetic functions, for example, are elicited in states of pain, fear, and rage; the cranio-sacral activities predominate when the organism is quietly feeding or resting. Thus the sympathetic portion of the autonomic system has an emergency function in that it is aroused during a crisis. On the other hand, the cranio-sacral portion acts as a conserver of bodily resources. Bodily excitement and bodily calm are perhaps the two opposed terms that most concisely express the antagonistic effects of the autonomic nervous system.

Cannon finds that the adrenal glands function in connection with the sympathetic portion of the autonomic system. Adrenin, the hormone secreted by these glands, primarily func-

tions by liberating sugar from the liver into the blood stream. Such an increase in blood sugar makes a larger supply of energy available. When more sugar is released than the body can consume the resulting effect is glycosuria, or the condition which, when chronic, is directly responsible for the disease diabetes. Cannon discovered that glycosuria developed in cats that had been confined in the presence of dogs for a time, in football players on the eve of a crucial game, and in some medical students just before a hard examination. Grief and anxiety result in glycosuria, hence individuals who suffer from some prolonged emotional strain, such as soldiers on the battle-front, are subject to diabetes of emotional origin.

Adrenin produces some further effects. It drives blood from the abdominal viscera into the heart, lungs, body, and the central nervous system, or into those regions of the body where it is needed in a crisis. Adrenin also increases arterial pressure and coagulates blood. Its most immediately useful effect, however, is to abolish or relieve muscular fatigue. Evidence indicates that it does this by neutralizing fatigue toxins in the blood.

That the effects of adrenin are comparable with the action of the sympathetic segments of the autonomic system is obvious. The sympathetic nerve impulses that produce visceral changes also stimulate the adrenals, and some of the symptoms of sympathetic activity are due to adrenal activity.

Emotions

As we have stated, all emotions are motives. Just as hunger impels the organisms to obtain and devour food, so fear prompts it to flee from danger, and anger spurs it to belligerent activity. While certain emotions are depressing or inhibitory, their effects upon behavior are none the less immediate and marked; hence they are true motives. Woodworth (33) has the motivating aspect of emotion in mind when he writes of its *impulsive* phase. By this he means that each emotion is in

part a tendency to *act* in some characteristic way. In general, emotions are motivating factors in behavior to the extent that they are strong or intense. To reverse the statement, strong emotions are those which exercise marked effects upon behavior.

Since modern psychology stresses the physiological approach to the study of emotion, attention should be called to the intimate relationships that exist between emotions and physiological drives. Closely associated with the sex drive is the emotion of love. The latter is undoubtedly derived from the former. In many respects such organic states as hunger, pain, and weariness possess features in common with the emotions. Frequently it is difficult to decide whether boredom is an emotion or an organic condition. The view is advanced in this chapter that emotions are physiological drives upon which many different kinds of stimuli have become conditioned. As far as the nature of the response is concerned, hunger is as truly an emotion as love. It differs from love primarily in the fact that its stimuli are limited in scope. If physiological hunger could be aroused and satisfied by landscapes, flowers, novels, and motion pictures, it would in truth be an emotion.

The James-Lange Theory of Emotion. From the historical standpoint, at least, the greatest theoretical contribution ever made to the psychology of emotion is an explanation of its general nature formulated about 1884 by Carl Georg Lange, a Danish physician, and by William James, an American psychologist. Since these men working independently arrived at the same general conclusion, their combined contribution is known as the James-Lange theory of emotion.

In order to appreciate the significance of this theory, we must note the fact that at the time of its formulation few scientific attempts had been made to place emotion upon a definite physiological basis. Emotions were popularly regarded as vague, ethereal states of mind or consciousness totally incapable of scientific analysis. As a result of the

prevailing view that distinguished sharply between the spirit and the flesh, emotions which possessed a high social value were regarded as essentially spiritual or mystical, while other emotions, of questionable moral worth, were classified as base, physical passions. In short, the emotions primarily interested poets and mystics. Nor was the psychological treatment of that period much more scientific, for it was concerned largely with extensive and formal classifications of (assumed) emotional entities. Moreover, this so-called psychological treatment strongly reflected the popular views just mentioned.

In reality, the ancient Greek thinkers rather than the writers of the last few centuries anticipated the James-Lange theory of emotion. The fact that they recognized the physiological nature of emotion is disclosed by their belief in "humors," or substances which were supposed to circulate in the body and cause the various emotions. A vestige of this belief is found in the expressions, "good" or "bad" humor. But it must not be inferred that the Greek philosophers thought of psychological problems from the modern standpoint, or even that they had a differentiated science of psychology. Their writings merely indicate a realization of the physiological correlates of emotion.

In essence the James-Lange theory explains emotions as conscious states directly caused by physiological activities. More specifically, it regards emotions as fusions of bodily sensations that are aroused, like other groups of sensations, by the stimulation of sense organs attached to sensory nerves. In terms of modern nomenclature, both James and Lange identified the emotions chiefly with interoceptive sensations. Lange emphasized the vasomotor or circulatory system as the source of emotions, while James included the entire viscera and the striped musculature. They agreed on the physiological nature of emotions, differing only in the specific physiological mechanisms involved.

The physiological activities responsible for these sensations

are, according to James and Lange, nothing more than the so-called expressions of the emotions. Thus, the human expressions of fear include in part a cringing bodily posture, trembling and partial paralysis, wide-open or protruding eyes, "gooseflesh," spasmodic and vigorous heart action, labored breathing, marked vasomotor changes and an altered tonicity of the alimentary canal. Anger, love, jealousy, and other emotions show other typical expressions or physical symptoms. While James and Lange were sure only of such expressions as are readily observable, they were convinced that these manifestations could account for the coarser emotions. As regards their analysis of the emotions, they were directly indebted to Darwin, who had published in 1872 his *Expressions of the Emotions in Man and Animals*. Darwin elaborated a theory of the origin of emotional expressions, but it remained for James and Lange to explain the psychology of emotion in terms of these expressions.

In addition to its emphasis upon the physiological nature of emotion, the James-Lange theory reverses the commonly accepted notion that emotion is a cause and its manifestation an effect. On the contrary, it definitely regards the emotional consciousness or "feeling" as a result of the physiological disturbance. It assumes that the steps involved in emotion are, in logical sequence, (1) the stimulus or exciting situation, (2) the physiological changes, and (3) the consciousness of these changes, or the emotion itself. In the case of an individual terrified by the sudden discovery of a rattlesnake at his feet, these steps are represented by his perception of the reptile, his physiological expressions of fear, and his state of consciousness resulting directly from his physical commotion. In other words, fear consists of certain characteristic "creepy" feelings on the skin, the sensations aroused by trembling muscles, and the disagreeable feeling-tone of the viscera. To the extent that they involve physical manifestations, all emotions like-

wise consist of typical groups of sensations. Emotion is the conscious result of bodily *commotion.*

James epitomizes his theory in the following words: "Our natural way of thinking about these standard emotions is that the mental perception of some fact excites the mental affection called the emotion, and that this latter state of mind gives rise to the bodily expression. My thesis on the contrary is that the bodily changes follow directly the perception of the exciting fact and that our feeling of the same changes as they occur is the emotion."

In another passage James explains his position in terms of an illustration that is commonly cited and usually misunderstood. In spite of the usual assumption that a man runs because he is afraid—so James states it—the truth is that he is afraid because he runs. The point is merely that the act of running represents the total physiological series of fear disturbances that cause the feeling or the emotion. James does not mean that the sensations from the legs of the runner alone constitute his fear.

Nor does James imply that there is a perceptible time interval between the physiological disturbance and the emotional consciousness. Although retinal stimulation actually precedes visual consciousness, no introspector can detect the time interval involved; and by the same token, the emotion apparently occurs simultaneously with its cause, the physiological changes. In stating that the bodily change comes first and the emotion second, James clearly is stressing the *logical,* not the psychological, sequence of the two events.

James bases his theory primarily upon real and hypothetical introspective evidence. His argument is as follows: "If we fancy some strong emotion, and then try to abstract from our consciousness of it all the feelings of its characteristic bodily symptoms, we find we have nothing left behind, no 'mind-stuff' out of which the emotion can be constituted, and that a cold and neutral state of intellectual perception is all that re-

mains . . . purely disembodied human emotion is a nonentity." According to this argument, intellectual apprehension of danger differs from the emotion of fear. The fireman, for instance, entrapped in a burning building, may be more keenly aware of the danger and at the same time less fearful of the consequences than an occupant whom he has just discovered. To put the case another way, if we can imagine some drug in tablet form, endowed with properties that restore all disturbed physiological functions to their normal operating level, we can readily believe that its specific effect would be anti-emotional. James finds additional evidence for his theory in the emotional behavior of many insane patients. Although this behavior is outwardly violent, James maintains that it is devoid of the inward commotion that is the essence of a genuine emotion. His point is that lacking the actual physiological disturbances, such emotional behavior, while apparently violent, is actually superficial and shallow.

James also advances the argument that the assumptions of the relationships that obtain between brain activity and conscious states corroborate his explanation of emotion. Since all brain centers directly associated with consciousness are sensory, emotion is either located in sensory centers or in other centers that have escaped discovery. And since the surface of the brain cortex, containing the known sensory centers, has been carefully explored, James believes that the existence of specific centers for emotion is highly improbable. We should note that while this conception of definite cortical centers is scarcely in accord with modern interpretations of cerebral functions, it was, in James's day, the accepted view. His argument, therefore, is extremely plausible in the light of his knowledge.

Criticisms of the James-Lange Theory. In spite of its tremendous influence upon psychological doctrine, the James-Lange theory has been subjected to severe criticisms from its first appearance to the present. These criticisms are of three

sorts, based respectively upon (1) logical arguments, (2) introspective considerations, and (3) experimental evidence.

Arguments of the first type may be summarized as follows: (1) It is urged that an emotion consists of factors other than the kinesthetic and organic sensations stressed by James and Lange. This is the argument so frequently advanced in other connections; namely, that a given theory is correct so far as it goes, but that it does not go far enough. Concerning the fact involved, there is little question if we can trust the observations of most psychologists. Hunter (17), for instance, finds in every emotion, in addition to its core of bodily sensations, an affective element of pleasantness or unpleasantness, and "an awareness of some thought or object as the arouser of the emotion."[1] But as Hunter points out, this fact does not argue against the James-Lange theory as interpreted by James himself, for James claims that the sensation-element is the determining, rather than the sole, factor in emotion. And it should be remembered that James consistently restricts his theory to the "coarser" emotions.

(2) Many psychologists, including those who are generally sympathetic with the James-Lange explanation, find that the theory fails to indicate the differentiating factors in the specific emotions. They note that many diverse emotions are manifested by the same bodily disturbances, and conversely, that the same emotion subjectively analyzed shows a variety of physiological expressions. For instance, running and some of its accompanying physiological activities characterize either fear or joy; and grief is expressed either actively or passively, with marked differences in the respective bodily disturbances. As we note below, Cannon voices this criticism on the basis of experimental data. That the James-Lange theory is entirely inadequate with respect to this issue can scarcely be questioned, but it does not follow that the discovery of the dif-

[1] *Op. cit.*, p. 199.

ferentiating factor or factors will militate against the theory. In the first place, the answer to the first criticism made against James and Lange is equally applicable to the second. Granting the existence of specific differentiating factors in emotion, it may still be true that the factor common to all emotions is the background of kinesthetic and particularly organic or visceral sensations. In the second place, we cannot assume that a scientific classification of emotions, when it is properly elaborated, will correspond at all with our present conception of the different emotions. On purely introspective grounds we seemingly experience emotions for which we have neither verbal designations nor accurate descriptions. It might be better, as Watson, Max Meyer, and others have implied, to designate the specific emotions as *x*, *y*, and *z*, and to avoid popular dictionary terms altogether. Furthermore, the characteristic physiological changes that underlie the various emotions have not as yet been described. It is futile, therefore, to criticize the James-Lange theory for its failure to differentiate among the specific emotions when the emotions themselves have never been adequately distinguished. It is conceivable, for instance, that there are only two kinds of emotion, pleasant and unpleasant, and that all other distinguishing features are really differences in the objective or ideational setting.

According to a popular objection to the James-Lange theory, also based upon alleged introspective evidence, an emotion is really intensified rather than weakened by a suppression of its physiological manifestations. It is argued, for example, that silent, controlled grief is much more poignant than this same emotion violently expressed. Although superficially plausible, this objection is rather pointless in that it does not take into consideration the ambiguity in the word *controlled*. In the majority of cases to "control" an emotion means merely to inhibit its outward, visible expressions, with no attempt to modify what well may be the important factors in the emotion

—namely, smooth muscle tonicity and endocrinal activity. In this sense control merely means repression or restraint. On the other hand, it is quite likely that when the inner as well as the outer physiological expressions of an emotion disappear, the emotion ceases to exist. One method of quelling an emotional condition is to neutralize it by engaging in some physical activity. Whistling to keep up courage is a familiar instance. Certainly the facts of everyday observation can be interpreted in favor of James's standpoint.

(3) Two physiologists, Sherrington and Cannon, have criticized the James-Lange theory. (a) Sherrington transected the spinal cords of some dogs in the lower cervical region in the attempt to eliminate visceral sensations from the emotional responses of the animals. He found, however, no alteration in the subsequent emotional behavior, and concluded that organic sensations (or processes) are not necessary components of emotion. In another experiment, using two of the same dogs, he cut both of the vagus nerves, thus eliminating possible sensations from the stomach, lungs, and heart. Again the dogs growled when teased and displayed as many apparent signs of emotion as their condition permitted. And to prove that his animals did not react with emotional habits acquired through experience and "stored" in the brain, where sensory-motor connections were still intact after the operation, Sherrington repeated his experiment upon puppies nine weeks old and obtained similar results.

But the majority of psychologists regard Sherrington's results as inconclusive. He merely established the fact that certain elements in the total emotional response, namely, those unaffected by the operation, can be elicited after the nerve connections between the viscera and brain have been severed. In other words, he did not prove that the dogs really experienced emotion.

(b) A second physiologist who attacks James and Lange is Cannon, whose investigations of certain visceral functions have

already been described. Cannon believes that the visceral changes involved in the emotions are determined by the intensity rather than the quality of the emotion. For instance, he cites a case where vomiting was stimulated in one highly nervous individual upon the receipt of extremely good news. If Cannon is correct, intense joy, sorrow, and disgust all tend to produce the same physiological effect. His conclusion is that "the viscera are relatively unimportant in an emotional complex, especially in contributing differential features." But as Hunter points out, Cannon "wrongly interprets his facts as antagonistic to the James-Lange theory. On the contrary, they support the theory strongly by indicating a very delicate and widespread bodily disturbance during emotional seizures." [1] It is certain that Cannon's investigations point to visceral activities as the probable location of emotional response.

The Expression of the Emotions. Whether or not the James-Lange theory is accepted in substance, we are forced through want of a better term to designate the physiological signs by which an emotion is manifested as the *expressions* of that emotion. Furthermore, the term is somewhat ambiguous in that it is frequently limited to such manifestations of emotion as are externally observable, whereas it logically includes all physiological changes in the total emotional complex. As used in the latter sense, for instance, it includes endocrinal activity.

Unfortunately for the theoretical considerations involved, the specific forms of emotional expression have not as yet been fully ascertained. Our knowledge of emotions in animals is meager for the simple reason that few people have taken the pains to observe such phenomena systematically. One might suppose that human manifestations of emotion, particularly bodily attitudes, gestures, and facial expressions, could

[1] *Op. cit.*, p. 203.

be readily studied in the photographic laboratory or moving-picture studio, but for reasons explained below such is not the case. Although based primarily upon personal observation, Darwin's classic description of emotional behavior in men and animals is still accepted as reasonably authentic. At best, systematic descriptions of emotional symptoms present composite pictures based upon numerous cases rather than individual pictures.

Among other descriptions of this sort, Bernard (5), in his book on the instinct hypothesis, gives Thorndike's analysis of anger.[1] The analysis is in fact a symptomatology of anger, not wholly applicable to any particular individual. Thorndike's description includes the following: heartbeat and circulation affected, face reddens, face becomes purple, veins on forehead distended, falling down dead, respiration affected, chest heaves, nostrils dilate, nostrils quiver, muscles become stronger, will becomes more active, body held erect for instant action, body bent forward toward the offending person, limbs rigid, mouth closed with firmness, teeth clenched, teeth ground together, teeth grinding, arms raised, fists clenched, menacing gestures, striking objects, hurling objects to the ground, children rolling on the ground on their bellies, screaming, kicking, scratching, biting, trembling, lips paralyzed, voice sticks in throat, voice loud, voice harsh, voice discordant, mouth froths, hair bristles, frowning, eyes glare, eyes glisten, eyes protrude, lips protrude, lips retract, snarling, flow of tears, spitting, yelling, slapping, pulling objects, shaking objects, stamping, jumping up and down, hitting with the hand.

The symptomatology of the major emotions—anger, fear, and affection—is formulated in detail by Morrison (23), in her investigation of the emotional behavior of mental defectives. Since they direct attention to all characteristic forms of emotional expression, arranged and classified systematically, Mor-

[1] *Op. cit.*, pp. 382-388.

rison's descriptions are germane to our present topic. They are as follows:

ANGER

1. Expression of the Face
   (a) Brows contracted, eyes narrowed
   Brows raised, eyes wide and glaring
   Brows level, eyes fixed, glance cold and steady
   (b) Mouth closed, lips thin, jaws set
   Mouth open (as in loud speech)
   Mouth opened slightly, lips curled, or twisted
   (c) Nostrils distended
   (d) Face flushed, pale, or of blotchy appearance
   (e) Perspiration on forehead and upper lip
2. Vocal-motor Reactions
   (a) Nasal and guttural sounds
   (b) Cursing, sarcasm, insults, etc.
   (c) Voice loud, hoarse, or low and threatening
3. Cardio-respiratory and Vasomotor Reactions
   (a) Very marked chest movements, deep and rapid breathing
   (b) Increased strength and rate of heartbeat (seldom observed)
   (c) Blood vessels of neck, face, and arms distended
   (d) Color of skin, flushed or pale
4. Posture and Movements of the Body
   (a) Erect, rigid
   Slightly crouched, and bent forward
   (b) Trembling
   (c) Running toward or throwing body against the offending object
   Spitting upon the object
5. Position and Movements of the Limbs
   (a) Fists clenched
   Fingers claw-like
   (b) Emphatic gestures of arms accompanying angry words
   (c) Pulling hair, striking, kicking
6. General Attitude
   (a) Unsociable
   (b) Disobedient, resentful
   (c) Irritable, sullen

FEAR

1. Expression of the Face
   (a) Eyes staring, brows raised

(b) Mouth open, lips quivering
(c) Nostrils distended
(d) Face pale, or possibly flushed
(e) Cold perspiration

2. Vocal-motor Reactions
   (a) Cries, screaming
   (b) Words of distress, pain, etc.
   Prohibitive commands
   (c) Voice husky, loud and high, hushed and low
3. Cardio-respiratory and Vasomotor Reactions
   (a) Very marked chest movements, deep and rapid breathing
   (b) Increased strength and rate of heartbeat (seldom observed)
   (c) Blood vessels of neck, face, and arms distended
   (d) Color of skin, pale or flushed
4. Posture and Movements of the Body
   (a) Body rigid, motionless
   Crouched
   Withdrawing
   (b) Trembling
   Shivering
   Erection of hair
   (c) Drawing or shrinking away
   Headlong flight
5. Position and Movements of the Limbs
   (a) Hands clenched or shaking
   (b) Arms thrust forward or thrown up toward face as if to push away or ward off the fearful thing
   (c) Actually pushing away the fearful object
   Striking, kicking, fighting
6. General Attitude
   (a) Of desire not to be alone
   (b) Refusal to go to certain places
   (c) Despondency, tearfulness

AFFECTION

1. Expression of the Face
   (a) Eyes bright, open, focused on the attractive object
   Brows raised or level
   (b) Mouth smiling, kissing
   (c) Face flushed as in blushing
2. Vocal-motor Reactions
   (a) Crooning, gurgling, etc.

(b) Pleasant, friendly speech
Soothing and endearing words spoken to or about the object of affection
(c) Voice calm and low, clear and hearty

3. Cardio-respiratory and Vasomotor Reactions
(These responses are very difficult to detect in affection, but we do get a hint of them in blushing)
4. Posture and Movements of the Body
(a) Posture relaxed, comfortable
(b) Leaning toward or against the attractive object
(c) Walking or running toward it
5. Position and Movements of the Limbs
(a) Hands relaxed, or spread out as in patting
(b) Gestures slow and gentle, as in stroking and patting
Protective gestures
(c) Caressing, embracing
Striking, kicking, even fighting to protect the beloved object
6. General Attitude
(a) Friendly, sociable, talkative
(b) Desire to be near the beloved object
(c) Pain or distress (tears) when separated from the beloved object
(d) Desire to do for and give to the beloved object

The Origin of Emotional Expressions. Any discussion of the origin of emotional expressions logically begins with Darwin's evolutionary theory, formulated in his *Expressions of the Emotions in Man and Animals*. Darwin's explanation takes the form of three principles that may be stated briefly as follows: (1) According to the *Principle of Serviceable Associated Habits* many forms of emotional expression are inherited vestiges of acts useful during an earlier period of racial history. For example, the snarl of anger shown by a dog and the corresponding scornful curl of the lips shown by human beings both date back to remote times when common ancestors exposed their teeth in fighting. (2) The *Principle of Antithesis* assumes that the emotions are arranged in pairs of opposites, and that an animal in any emotion tends to manifest expressions the opposite of its paired emotion. To quote Allport's (3) example, "Thus the cringing and fawning of the happy,

affectionate dog, together with his lowered ears and tail, and sinuous movements, could be understood only as the opposites of the erect and stiffened posture, and pricked up ears and tail, of the dog in anger."[1] (3) The *Principle of the Direct Action of the Nervous System* assumes, something after the manner of present-day popular belief, that in strong emotion there is an overflow of nervous energy into the available motor channels. Trembling, for instance, is explained on this basis.

Darwin's principles, particularly his first, seem applicable to many familiar forms of expression. It is conceivable that we open our eyes in fear because our ancestors faced dangerous situations chiefly at night when the clearest vision possible was imperative. In the same way, disgust involves the expression of physical nausea. The individual who scathingly addresses the object of his scorn by the remark, "You make me sick," speaks better psychology than he realizes. A more far-fetched example of assumed survival value is found in the bristling attitude of a terrified cat. By apparently doubling its size, the cat inspires respect if not fear in its enemy. In addition to being somewhat negative, Darwin's second principle is open to the charge that emotions, as a matter of fact, do not show the paired arrangement that the explanation presupposes. It is of course obvious that his third principle is sufficiently elastic to cover any emotional expression of dubious practical value.

In essence at least, Darwin's theory of emotional expression has been adopted by many biologists and psychologists. It forms the basis of James's theory, for when confronted with the task of explaining the bodily disturbances that constitute the emotions, James assumes their instinctive origin and their ancestral value. In more recent times, the influence of Darwin is seen in the physiological studies of emotion made by Crile and Cannon. Both of these physiologists find survival values in visceral functions, and Crile (12) finds them in the con-

[1] *Op. cit.*, p. 211.

scious accompaniments of visceral functions. For instance, he states that pain due to lacerations of the flesh is almost unendurably unpleasant because it dates back to the experiences of our ancestors who coped with carnivorous beasts, while the pain that results from bullet wounds, having no evolutionary significance, is relatively mild. As we point out below, Cannon finds a biological purpose in the visceral accompaniments of emotion.

Nevertheless, Darwin's method of explanation has been criticized from two distinct points of view. In the first place, his basic assumption regarding the evolutionary process has been considerably modified by more recent biologists, and his specific theory of emotional expression has suffered accordingly. Allport has reformulated Darwin's principles in the light of modern biological doctrine. In the second place, as we show presently, Darwin's view does not square with all of the facts of human facial expression. Taken together, the two criticisms probably represent the trend of modern views concerning emotional expression.

Allport believes that Darwin's principles should be reformulated rather than discarded. Referring to Darwin's idea of the origin of facial expression, Allport makes the following comment: He "demonstrated that facial expression, or communication, was not the original function of the facial muscles; but that such biological ends as mastication, dilatation of the nostrils for breathing, and shading the eyes were their proper functions. The purpose to express was therefore not the origin of this behavior."[1]

Allport then revises each of Darwin's three principles in conformity with present scientific knowledge. He substitutes for Darwin's first theory the explanation that emotional expressions have survived because they *become* important in the adaptation of the *individual* to the environment. In other words, they are acquired just as language is acquired. Allport

[1] *Op. cit.*, p. 211.

revises Darwin's first principle as follows: "Darwin's formula was, 'The ancestor bites in angry attacks and the child instinctively expresses rage by baring his teeth!' Our revision would read, 'The *child* bites and so acquires the habit of expressing rage by baring his teeth.'"[1] The principle of antithesis Allport modifies in terms of his emphasis upon the opposed affective states, pleasantness and unpleasantness, as the essential components of emotions. The principle of the direct action of the nervous system, according to Allport, can be retained by assuming that facial expressions are partly controlled by the autonomic system. For example, blushing is a vasomotor phenomenon which can be explained only in terms of a relatively widespread autonomic disturbance.

Studies of Emotional Expression. It will be remembered that, according to the second criticism, Darwin's view does not harmonize with the facts of emotional expression. The acceptance of Darwin's theory implies that various human emotions are represented by relatively fixed and characteristic facial expressions. Thus grief, love, anger, disgust, fear, and surprise should each, according to Darwin's view, conform rather closely to inherited emotional patterns. To the extent that facial expressions suggest an inherited, original purpose, they should conform to type.

On the other hand, two considerations argue against the assumption that emotional expressions are necessarily or even usually stereotyped. In the first place, these expressions are determined or at least modified tremendously by social convention. Current manifestations of grief in American polite society differ considerably from the custom, described in novels, which prompted the bereaved Russian peasant to wail audibly and publicly in front of his house. It can scarcely be argued that the latter custom, with its entailed publicity, is any more "natural" than our own. As a matter of fact, education and social progress tend to subdue all forms of emo-

[1] *Op. cit.*, pp. 214-215.

tional expression. Then, inasmuch as emotional expressions possess certain linguistic or communicative functions, they tend to become not only subdued but conventionalized. The moving-picture public soon accepts the artificial and conventionalized methods of registering emotion that it views on the screen. In fact, for reasons which need not detain us here, moving-picture actors have reduced their repertoire of emotional expressions to a minimum. A number of *Life* pokes fun at this tendency by caricaturing the actress in her attempt to register a series of emotions—all attempts resulting in identical, wooden expressions. It must be acknowledged that the conventionalized emotions seen on the screen or stage represent a very real trend in emotional manifestation.

Secondly, psychological investigations have shown that judges have difficulty in identifying emotional expressions registered in photographs. In Feleky's (14) study a talented subject posed for numerous photographs of various emotions during a period of a year. Eighty-six of these photographs were finally selected and given to a group of 100 judges. They were able to agree upon certain expressions, such as aversion, contempt, and laughter, but they failed with others. Ruckmick (26) conducted a similar experiment, using a subject with considerable experience in amateur dramatics. Among other conclusions, Ruckmick states that ". . . as a rule the 'primary' emotions, as love and hate, joy and sorrow, are much more uniformly interpreted than the 'secondary' ones, like repulsiveness, surprise, distrust and defiance." Moreover, this investigator notes that judgments of facial expressions are modified by the moods of the judges.

Allport gives a summary of an investigation conducted and reported by Langfeld (20, 21). This experimenter obtained judgments of emotional expression based upon photographs posed for by an experienced actor. To quote Allport's summary: "In some of these tests five subjects were used, and in others, six. The subjects examined the photographs and

named the expressions in their own words. A total of 525 judgments were obtained, of which only about 33 per cent were correct. If only the eight groups in the . . . table are selected (the others being unusually difficult or perhaps only 'projected' expressions) the accuracy rises to 43 per cent, which is still surprisingly low. Laughter was the most readily identified, being correctly named in 64 per cent of the cases; anger the least readily (30 per cent accuracy). Pain was also readily seen (50 per cent); while disgust and fear were low (36 per cent each)."[1]

Using the same series of photographs, Allport conducted a further test in which he asked his judges to underline one of eight titles for a given picture, only one of which was absolutely correct. Fourteen groups of names were used in all. In other words, the judges were furnished names from which they selected what they thought were the correct names. Under the conditions imposed by this method their judgments were 45-50 per cent correct.

Allport further gives the order of identifiability obtained by himself and by Langfeld. The two lists, containing the facial expressions ranked in the order in which they were correctly identified, are as follows:

(Langfeld) 6 subjects—105 pictures	(Allport) 48 subjects—14 pictures
Laughter	Laughter
Amazement	Bodily Pain
Bodily Pain	Fear (Horror)
Hate (Aversion-Hate Group)	Distrust (similar to Hate)
Fear (Anxiety-Fear-Terror Group)	Amazement
Disgust (Scorn-Contempt Group)	Anger
Doubt	Doubt
Anger (Anger-Rage Group)	Disgust

That the general conclusions just advanced apply to actual emotions is confirmed by the experiment of Landis (19). This

[1] *Op. cit.*, p. 223.

investigator photographed people who were under the stress of various emotions. In order to obtain genuine emotional responses, he was forced to administer rather heroic stimuli to his subjects. Some of the stimuli that proved to be really effective were jazz music, severe electrical shocks, pictures of loathsome diseases, touching live frogs concealed from vision, instructions to write and to read aloud (actually enforced) bits of embarrassing personal history, instructions (also enforced) to pick up a live rat with bare hands and decapitate it with a knife. The facial responses to these situations were photographed with extreme care. In one of his series black lines were drawn on the subjects' faces in order to make the facial expressions more visible.

From the standpoint of the present discussion, the most significant result obtained by Landis was that individuals vary exceedingly in responding to the same emotional situations. As he states the result, "In no situation was the contraction of a muscle, group of muscles, or expression found to occur with sufficient frequency as to be significant. There is no expression typical of any situation in this experiment." [1] Moreover, each of the subjects manifested a tendency to use certain characteristic facial expressions in responding to stimuli, irrespective of the nature of the stimuli. In brief, facial expressions are determined primarily by the individual and not by the emotional situation. Landis also found little correspondence between verbal reports of emotional states and the facial expressions of these states. In other words, there was no facial expression typically associated with any verbal description of the emotion offered by the subjects. On the basis of his results, Landis suggests that a distinction should be made between social and emotional expressions. Natural expressions of emotions are individual peculiarities, while the expressions that are ordinarily registered are highly conventionalized. The latter constitute the *language* of the face.

[1] *Op. cit.*, p. 497.

Physiological Manifestations of Emotions. The term, *"expressions of the emotions,"* is really misleading. It reflects the old belief that the physiological disturbances which it includes are caused by subjective states or the "true" emotions. As a matter of fact, few contemporary psychologists, including even those who reject the James-Lange theory, accept this belief without considerable qualification. The term is ambiguous in its failure to distinguish between *all* physiological manifestations of emotion and merely those that are subject to voluntary control. In their courses of instruction schools of dramatic art naturally emphasize voice, gesture, bodily attitude, and other controllable elements in emotion, rather than smooth muscle tonicity or endocrinal activity. However, many psychologists seek an explanation of feeling and emotion in visceral functions. Inasmuch as these functions are included in the phenomena which theories of emotional expression attempt to explain, they are properly classified under this term.

Emotion and Gastro-Intestinal Tone. While numerous investigators have assumed that the tonicity of the smooth musculature is closely related to emotional phenomena, the experimental evidence bearing upon this assumption is exceedingly meager. In many strictly physiological investigations of visceral functions, smooth muscle tissue is either exposed to direct observation in the anesthetized animal or excised and studied while still living. But emotional phenomena are only manifested in the intact organism. Furthermore, even the trained observer has difficulty in studying his own visceral behavior.

One investigator, Brunswick (7), was able to study the effects of emotional stimuli upon the tonicity of the human alimentary tract, and to check his experimental results with introspective data. His results are of interest with respect to the physiological aspects of emotion, and they are related to the James-Lange theory. Using the rubber balloon technique,

Brunswick obtained kymograph records of changes in tonicity in the lower end of the alimentary canal, and in the stomach. In addition he recorded fluctuations in breathing by means of a *pneumograph.* Changes in blood pressure were also recorded throughout the experiment. The subjects, 10 adults in the Johns Hopkins University, gave introspective testimony regarding their conscious reactions to strong emotional stimuli while their physiological responses were being automatically registered. Brunswick's conclusions are based upon both the physiological and the introspective findings.

A word should be said concerning the laboratory study of emotion. As our account of the experiment of Landis indicates, it is possible to elicit genuine emotions in the psychological laboratory, under conditions of controlled observation, provided that mature subjects are used. It is well known that certain emotional responses, disgust for example, can be provoked readily in the majority of human beings by appropriate pictures or verbal descriptions. The responses are none the less genuine even though they are deliberately aroused for purposes of investigation. In the psychological laboratory subjects are selected primarily on the basis of their interest in science, as shown by their willingness to act as subjects. When an experimenter undertakes the study of emotion, or any phenomenon requiring trained observers, he devises his technique, selects his subjects, asks them to report at certain periods, and gives them in advance such information about his experiment as seems advisable. Brunswick followed this general procedure, but as one might surmise, he did not inform the subjects regarding the stimuli which he had prepared for them. These stimuli included an unannounced turning off the light, an unexpected pistol shot, a threat to shoot a pistol aimed in the direction of the subject's head, an actual shot fired close to the head of the subject, dashing water into the face, the odor of decayed meat, a live snake that the subject was required to pick up, and an electrical shock. As his re-

sults show, some of these stimuli were exceedingly effective in arousing emotions.

Brunswick compared three chief factors controlled in his investigation; namely, the emotional stimuli, the changes in visceral tonicity, and the introspective reports. He found that the following emotions are characterized by relaxation or loss of tonicity in the stomach: fear, envy, disappointment, irritation, pain, and unpleasantness. As opposed to these, some of the emotions correlated with stomach contraction, or increased tonicity, are disgust, surprise, tenseness, wonder, anger, relief, pleasantness, interest, and amusement. His results, it should be said, were marked by a few discrepancies.

On the basis of these discoveries, Brunswick concluded that tonic changes in the gastro-intestinal walls are actual factors in emotion. He is inclined to think that with better introspective technique and more sensitive apparatus such inconsistencies as he found would be eliminated. His records of tonic changes, however, are not sufficiently differentiated to explain the specific emotions. There was not a characteristic change for anger, another one for fear, and still another for surprise. On the other hand, he was able to correlate changes in tonicity with feeling-tone; for on the whole pleasant emotions were marked by contraction or increased tonicity and unpleasant emotions by relaxation or loss of tonicity. Brunswick suggests that the sympathetic system is responsible for unpleasantness while the parasympathetic (or the craniosacral) is, conversely, the agent of pleasantness. In addition to the foregoing results, Brunswick found evidence for compensating emotional reactions. Anger is a compensation for fear, hence its accompanying increased tonicity as contrasted with the diminution of tone in the latter emotion.

Brunswick's results and conclusions are of interest in several respects. They are fundamentally significant from a technical standpoint in that they bring experimental evidence to bear upon certain deductions previously arrived at by other

psychologists. On the whole they support the James-Lange theory, for they tend to correlate emotion and feeling with bodily activity. They suggest that our popular ideas of the emotions stand in need of considerable revision. The traditional classifications of the emotions are entirely arbitrary, and our notions of the feeling-tone of emotions are extremely vague. In other words, it is possible that Brunswick's results fail to differentiate among the various emotions for the simple reason that they have never been adequately distinguished on introspective grounds. In conclusion, it should be noted that Brunswick investigated only one phase of the physiology of emotions. Neither the influence of circulatory nor of endocrinal factors is incorporated in his report.

Blood Pressure Symptoms of Deception. Marston (22) and other investigators have found that changes in systolic blood pressure accompany the conscious attitude of deception so closely that they are fairly reliable objective signs of this attitude. Blood exerts a pressure upon arterial walls in much the same way that water exerts pressure upon a fire hose. By means of a suitable instrument, the *sphygmomanometer,* this blood pressure can be measured. Marston took successive blood pressure measurements of subjects who were attempting to shield friends accused of hypothetical crimes or to deceive the experimenter regarding their own actions. His results indicate increased pressure during moments of attempted deception.

The Word-Association Method of Studying Emotion. In the opinion of many psychologists man is distinguished from the animals chiefly by his employment of language. As we shall explain in Chapter VI, words are symbols that replace concrete, stimulus-response situations. Forms of fiction, the novel in particular, attest to the fact that human beings can live through experiences of the utmost physical and social complexity on a plane exclusively verbal. As any ordinary conversation between two people shows, words function both

as stimuli and responses. But attention is called to the fact that the response to a verbal stimulus is in many cases not merely another word. It may be an overt act, as a movement executed by a soldier in response to a military command, or it may be an emotion. Frequently responses to verbal stimuli are quite complex, including emotional elements, overt responses, and other words.

The fact that verbal stimuli are exceedingly effective in arousing emotional reactions is utilized in everyday life. Our purely verbal responses are more or less mechanical and governed by habit. For example, practically the universal response to "black" is "white." But words associated with our emotional life, words that refer to people or situations that are sources of embarrassment, fear, hatred, jealousy, or love, produce mixed responses. Our verbal responses to such words are likely, for one thing, to "give us away," hence we inhibit them or seek other words as substitutes, and the net result is a *delay* accompanied with signs of confusion and embarrassment. Lawyers frequently apply this psychological principle while conducting cross-examinations; parents and teachers use it in controlling children.

In the psychological laboratory, this principle is utilized under controlled conditions in the interest of scientific research. As the experiment is usually conducted, the psychologist prepares a list of stimulus words and pronounces each of them to his subject, who is required to reply orally to each by the first word that comes to his mind. Using a stop-watch, the experimenter records the time interval that elapses between each stimulus word and its response. He writes the actual response word and records any signs of emotional reaction.

Before the experiment is begun, the stimulus words are carefully selected with reference to the desired responses. Normally such a list contains a number of *control* words; that is, words such as "up," "white," "table," "go," "sing," that are

presumed to be relatively free from emotional connotations. The average time required in responding to such words, known as the normal verbal reaction time, varies considerably from one individual to another. It is separately ascertained for each individual subject, therefore, as a basis for comparison with his responses to supposedly *significant* words. Words of this sort refer to events that are common sources of worry, fear, shame, embarrassment, or perhaps guilt. Words which thus tend to arouse strong emotional responses are called "complex" words.

The term *complex* is a product of the psychoanalytical school of Freud and Jung. Taken literally, psychoanalysis means analysis of the mind, but the term has been appropriated by this particular school of psychiatrists to designate the method by which its members ascertain and study the personal, subjective life of their patients. The psychoanalyst endeavors to delve into the mind of his patient for the purpose of discovering memories of important experiences which the patient himself will not or cannot recall. These experiences have been put out of the mind of the patient because they are sources of embarrassment or shame. The process by which an individual refuses to think of his unpleasant experiences until he forgets them entirely is called *repression.* The chief contention of the psychoanalyst is that repressed memories, instead of disappearing from the life of the individual, may affect his dreams, his thoughts, and his everyday acts to the extent that he becomes neurotic and even mentally unbalanced. Only by resurrecting these forgotten experiences can a cure be effected.

The complex is the group of ideas or memories that has been repressed. According to the extreme psychoanalysts, the ideas composing the complex exist only in the "unconscious." It should be remarked, however, that this usage of the term *unconscious* is purely figurative. The unconscious refers merely to the individual's more or less successfully inhibited

motives and impulses. If a child were taught that hunger is something to be ashamed of he would naturally refuse to acknowledge, to himself, his own hunger cravings; but his stomach rather than his "unconscious" would be the source of his unacknowledged desires. There is nothing particularly mysterious or metaphysical about complexes.

The *symptoms* of emotional disturbance recorded during a word-association test are called *complex indicators.* In an article by Hull and Lugoff (16) the following complex indicators are enumerated: long reaction time, abnormally short reaction time, inability to respond, repetition of stimulus word, apparent misunderstanding of the stimulus word, defective reproduction of original response at second presentation of stimulus word, responding with the same reaction word to two or more different stimulus words, meaningless reactions, perseveration. Such complex indicators, together with the nature of the response word itself, are frequently significant.

The Psychogalvanic Reflex. The galvanometer is an instrument which detects weak electrical currents. One form of the instrument serves this purpose by reflecting a beam of light from a swinging mirror. Movements of the mirror change the angle of the reflected light.

When the galvanometer is connected with the skin by electrodes, it is affected by the rate of secretion of the sweat glands. The resulting deflection of the light is called the *galvanic reflex.* Since the sweat glands are affected by emotions, the reflex, known also as the *psychogalvanic reflex,* indicates changes in emotional processes.[1] For instance, the British psychologist Smith (28) compared psychogalvanic measurements with differences in verbal reaction time, and concluded that the galvanometer detects complexes when reaction time fails to do so. On the other hand, the extreme

[1] Consult L. A. Jeffress, "Galvanic Phenomena of the Skin," *Journal of Experimental Psychology,* 1928, 11, pp. 130-144, for experimental evidence supporting this conclusion.

sensitivity of the instrument causes it to respond to many extraneous influences and therefore interferes with its usefulness in the psychological laboratory.

Other Devices for Detecting Emotion. Many of the physiological functions that constitute, or are correlated with, emotion are studied by means of special pieces of apparatus. The *plethysmograph* records changes in the volume of the blood in the hand or other parts of the body to which it is attached. It consists essentially of a rubber sleeve or glove into which the hand or part is fitted, surrounded by water which in turn fills a cylindrical vessel and communicates with a recording device. As the volume of blood increases or decreases, a tracing made on smoked paper goes up or down. The *pneumograph* measures changes in respiration by recording fluctuations in the circumference of the chest while breathing. The *automatograph,* the original form of the planchette or ouija board, records minute involuntary movements made by the arm. The *cardiograph* shows fluctuations of heart action. These instruments are exceedingly useful in studying emotion because they measure quantitative changes in the phenomena which they register.

Dream Analysis of Emotion. Freud and his followers maintain that dreams, when correctly interpreted, furnish unerring indications of emotional trends. The assumptions involved in this theory are briefly as follows: The basic human drive is sexual, and it is represented in mental life by the emotion of love. This drive, called the *libido,* frequently conflicts with the ideals of the individual who possesses it, in which case it may become repressed into his unconscious mental life.

But the repressed libido tends to assert itself whenever possible. Sleep furnishes such an opportunity because it is a state characterized by a diminished capacity for thinking and for making moral judgments. During sleep, therefore, the individual is morally off-guard, so that his repressed wishes

appear in his dreams. Freud explains further that the libido or wish is disguised, even in the dream, for otherwise its true nature would be revealed to the dreamer. This necessity for disguise explains the fantastic character of dreams. Thus, according to Freud, all dreams are symbolic fulfillments of repressed sexual motives.

A critical evaluation of the Freudian hypothesis would be out of place in the present discussion, but we may point out, nevertheless, that Freud's theory of dreams has been subjected to severe scientific criticism. It certainly lacks experimental confirmation. On the other hand, Freud has rendered a possible service to psychology by insisting upon some sort of relationship between dreams and motives. It is possible to doubt his fundamental assumption regarding the libido and at the same time to utilize his technique for dream analysis in the study of motivation.

Moods. Not infrequently an emotion perseveres long after its immediate cause has disappeared. This characteristic of emotional behavior gives rise to the phenomenon of *moods*. In terms of the stimulus-response principle an emotion finds opportunity for continued expression by attaching itself to a succession of stimuli. Once his anger is thoroughly aroused, a man may go about for some time seeking trouble. As we say, he is in an "ugly mood." Similarly, a state of depression caused by some trivial circumstance may color an individual's outlook for hours and even days. Fortunately, however, moods also characterize the happier emotions. The recipient of exceedingly joyful news at the breakfast table is likely to manifest considerable optimism throughout the day. The mood of an individual actually determines in part the stimuli to which he will react.

On the response side, an explanation of moods is found in the lethargy which characterizes visceral behavior, particularly with reference to the cessation of visceral activities. As compared with the skeletal muscles, smooth muscles begin to con-

tract slowly and cease contracting with even more delay. Cannon tells of a cat under fluoroscopic observation that showed no gastric peristalsis for several hours after it had been confronted with a dog, although its only objective manifestation of nervousness was a slight twitching of its tail. Digestion is a leisurely process which is recognized as instrumental in determining human moods. In all likelihood, too, temporary changes in endocrine functioning affect the organism for hours. In general, the ancient Greeks were not misled in their notion of the "humors" circulating through the body.

Temperament. The factors responsible for moods are relatively stable in the life of the organism. They form certain habitual modes of response and thus constitute the basis of *temperament*. As one might suspect, differences in temperament can be described from several standpoints, depending upon the factors which seem most instrumental in shaping personality. Several theories of temperament have been advanced, three of which stand out as fundamental.

(1) According to one view, an individual's temperament is determined by his most characteristic mood or moods. There are as many temperaments, therefore, as there are habitual moods. Pronounced tendencies to display fear, anger, and love respectively are seen in the timid, irascible, and affectionate types of temperaments. Likewise, mixed or derived emotional reactions, such as jealousy, envy, and worry, are represented by as many temperaments. This basis of classifying temperaments is open to many objections, but at least it possesses the merit of simplicity.

(2) Berman (4) assumes that temperaments are almost exclusively the products of endocrinal activities. According to Bridges (6), Galen's ancient description of the sanguine, phlegmatic, choleric, and melancholic temperaments is the historical antecedent of Berman's view. In Berman's opinion, our present knowledge of the ductless glands justifies the description of a temperament for each gland, or for certain glands

acting together. Thus, the restless and excitable individual belongs to the thyroid type of temperament. A person of the adrenal type is noted for his energy; or, if he shows a deficiency in adrenal secretion, he may develop into the neurasthenic patient who suffers from constant fatigue. The pituitary types are more complex, since they can be classified as masculine or feminine depending upon which lobe of the pituitary gland determines the personality. In general, the two pituitary types conform to the popular ideals of masculinity and femininity. When the thymus gland continues to function during childhood and adolescence, it gives rise to the "angel-child" personality. In a similar way, all types of personality are accounted for in terms of balances among glandular activities.

(3) A third basis for the classification of temperaments is found in abnormal behavior. Psychopathic and insane people are literally *abnormal* in that they represent deviations from the normal. In other words, their traits are exaggerations of traits found in all normal humans. But there are various kinds of insanity, just as there are different kinds of physical disease, hence it is theoretically possible to classify normal people on the basis of abnormal groups.

The psychiatrist Rosanoff (25) has elaborated one classification of abnormal people and described corresponding types of temperament. He recognizes four types; namely (a) the anti-social or criminal; (b) the cyclothymic, marked by periodic alternations of exalted and depressed moods; (c) the autistic, "shut-in," or self-centered type; and (d) the epileptic type, characterized by hypersensitivity, selfishness, and cruelty. As Rosanoff himself states, these distinctions are not sharply drawn in normal human beings. Like all type theories, they apply primarily to relatively extreme cases.

The psychoanalyst Jung has described two opposed types of personality or temperament by the terms *introversion* and *extroversion*. The introverted individual lives in a subjective

world, whereas the extrovert prefers the outer or objective world. The introvert is the day-dreamer, or perhaps the poet or mystic; the extrovert is the "practical" man of affairs, the inventor, business man, or statesman. A list of introverted traits compiled by Freyd (15) includes, among others, the following: self-consciousness, hypersensitivity, moodiness, hesitancy in making decisions, tendency towards introspection, self-depreciation as regards abilities, habits of working by fits and starts, and reticence. The corresponding extroverted traits would be the opposites of these. The two tendencies are found in both normal and abnormal people.

Social Motives

In the first part of this chapter attention was called to the social aspects of human motives. In a subsequent section of the chapter it was further disclosed that human emotional responses, as well as stimuli, are determined largely by social influences. The two phases of human nature, namely, the biological and the social, were found to be reflected in all human motives.

Our present and final problem is to analyze certain human motives in which the social factor predominates. That this is actually if not apparently the determining factor in many cases of human motivation has been repeatedly pointed out by a number of contemporary psychologists. Thus, during a charge on a battlefield more courage is required for a soldier to break ranks and flee to the rear than to "carry on" with his comrades. Again, it is not stretching the point unduly to say that fashions prevail in art, literature, and science just as they do in clothes and social etiquette. The standards are merely known by a more dignified term than fashion. While in the realm of music the standards of harmony are determined partly by the structure and mechanism of the ear, custom has not hesitated to violate these standards; so that frequently the discords of one generation become the accepted harmonies of

another. The same can be said of color combinations. Classic art is based upon physiological principles; it employs such color contrasts, justified by the mechanisms of the retina, as red and green, blue and yellow, black and white. But let custom sanction such a violation of these principles, for instance red upon a purple background, and it becomes accepted as esthetically pleasing. In science, government, and ethics, standards and modes of thinking develop and have their day. No intelligent man could argue that they are determined by purely rational considerations. Everything considered, human nature itself is largely a product of society.

The Concept of Social Consciousness. One of the first writers to emphasize man's dependence upon his fellows for his thoughts, emotions, and modes of conduct was the sociologist Cooley (11). This fact Cooley formulated in terms of *social consciousness,* or the view that the consciousness of an individual is the consciousness of the various social groups to which he belongs. For example, consider the college freshman whose previous life has been spent in a small town far removed from a college atmosphere. His existence has been bound up in a number of overlapping groups or circles—his family, his church group, his high school group, his circle of intimate friends. These groups have given him his personal habits, mannerisms, taste in clothing, intellectual interests, religious and moral convictions—in short, the elements of his personality and character. Of course there may have been conflicts among the groups—as when his friends began the practice of surreptitious smoking. Cooley would say that individuality is possible only when group standards are in conflict. On leaving his home town to enter college, the prospective freshman is suddenly torn from his established groups, and of course homesickness is the inevitable result. His only sources of relief are letters, the home town newspaper, and his memories. Greater social and educational opportunities are awaiting him, but the process of transferring from one set of social groups to

another is laborious and painful. In one word, he is "green." It goes without saying that the new groups into which he must fit himself are in many instances radically opposed to the old. But in the course of his four years at college the transition is made; and at the end of that period he is as reluctant to return home as he was originally to leave.

Of course many factors are discoverable in social motivation not provided for in our illustration. Many people avoid contact with actual, existing groups, preferring to live in fictitious groups. Indeed, many people seem to enjoy phantasy-building or day-dreaming. It will be noticed that day-dreams are highly socialized, and that the individual who indulges in them invariably enjoys in imagination a degree of prestige not accorded him by his real associates. Each day-dreamer is the hero of his own day-dreams. Cooley merely insists that all normal consciousness bears the imprint of the socializing process. A person may live entirely in the past, finding solace in memories of by-gone social standing and glory; or perhaps he prefers the future, and dreams of the time when his greatness will be accorded the recognition it deserves. As far as human motivation is concerned, Cooley has stressed the point that all normal human beings are motivated by the desire for *recognition.*

The Prestige Motive. A further analysis of this desire for recognition discloses the fact that it prompts each human being to assure himself of his superiority in some form over other human beings. In other words, all social motives reflect the fundamental *prestige* motive. Of the various specific social motives, the one most commonly manifested is the desire for notice or attention. Between the two evils of being utterly ignored or of being disparaged, the latter is by all odds the lesser. The notice that one receives from his fellows is frequently a mere formal greeting, but even in this case its prestige implications are obvious. The pleasure which the greeting arouses in the individual recognized is heightened

just to the extent that it issues from a worthy or estimable person—from a person capable of bestowing prestige. The servant is thrilled at some sign of recognition from his master, and immediately lords it over other servants less deserving of notice. To kiss the garment of a celebrity is an assertion of superiority as well as a token of subserviency. The same psychological effect is produced when one is recognized by a member of his own social group, for the recognition is accorded by one of a chosen or superior circle. While certain people boast of the fact that their circle of acquaintances is large, their boasting reveals anything but a democratic spirit.

When the desire for recognition takes a more active form than the desire to attract notice, its underlying prestige motive becomes all the more apparent. Consider the instance mentioned in the introductory portion of this chapter; namely, the desire to be complimented or praised. There is no denying the fact that a compliment always proclaims the superiority of the individual so favored. When a genius is informed about his brilliant achievements, or a girl told that she is beautiful, the compliments are pleasing because they are *distinctive*. On the other hand, nothing irritates an individual more than to be classed with other individuals. To be called *common* is to be grossly insulted. In fact, it is to escape the level of commonness that most of our social efforts are directed. The social climber has his prototype in all classes of human beings; in some way or another all human beings are social climbers. The prestige motive is dignified by such terms as self-respect and ambition, but its nature is none the less in evidence.

The Inferiority Complex. The Viennese psychiatrist and psychoanalyst, Alfred Adler (1, 2), has formulated a theory which explains behavior in terms of defeated or baffled prestige motives. Adler was interested in the neurotic constitution —that is, in the characteristic symptoms displayed by patients afflicted with nervous or mental diseases. According to his statement, all such patients suffer, or originally suffered, from

profound feelings or convictions of their own inferiority; and their attempts to escape from, or compensate for, these feelings gave rise to their neurotic symptoms. While Adler's primary concern was with abnormal motivation, his theory is equally adapted to explain normal human behavior. We have already pointed out the impossibility of distinguishing sharply between the two. In brief, Adler contends that all emotional complexes can be resolved into a general *inferiority* complex.

If Adler's observations are correct, neurotic patients are physically defective. They have weak eyes, hearts, or lungs; they are deformed, possibly just enough to handicap them socially; or perhaps they are afflicted with stammering or stuttering. This contention is significant, for Adler believes that the patient's abnormal nervous and mental symptoms are the physiological effects of his consciousness of physical inferiority.

We shall first examine the immediate effects of the feeling of inferiority, and then study the methods by which the individual obsessed by this feeling endeavors unconsciously to escape from it. Since the physical defects from which it springs as a rule go back to early childhood, we should note the early stages of such pernicious influences. A child physically handicapped is forced to realize that he cannot compete successfully with his normal playmates. Through no fault of his own he is the loser or slacker in competitive games and sports. Moreover, he is the target for the thoughtless ridicule of his associates, and among other indignities, likely as not, he is given a nickname inspired by his deformity or weakness. As the result of all this he is profoundly unhappy. He becomes morbidly hypersensitive, distrustful, jealous, and envious. As far as he is concerned, the happiness of childhood is fiction and myth.

All of this tends to make him an *unsocial* human being, hence an abnormal one. By a logical and natural process, the traits just enumerated develop into vindictiveness and cruelty.

Adler's theory bears out the statement frequently made that "catty" and hypercritical people are themselves unusually sensitive to personal criticism. Whether this holds or not the neurotic patient, according to Adler, is selfish and, when permitted to be, domineering. And it is but a step from these symptoms to others more serious in character. Jealousy and suspicion appear and prepare the way for delusions and hallucinations. Obsessions and fears become fixed in the patient. In extreme cases insanity is the final outcome.

The methods by which an individual convinced of his own inferiority endeavors to escape from the depression which it entails are called by Adler and other psychoanalysts *psychic* compensations. To illustrate, the domineering attitude mentioned above is an indirect effect of the inferiority feeling, or a compensation. Adler interprets this trait as an unconscious expression of the desire for superiority. The mark of superiority is authority and prestige, made known by the superior individual's ability to command and control others. The neurotic person attains this end by imposing upon his nurse and members of his family, or upon such playmates as happen to be weaker than he is. In other words he becomes the bully. His prototype is found in the typical factory "straw-boss," who, having a slight amount of authority bestowed upon him, proceeds to use it to the utmost. Thus Adler again substantiates a popular belief by pointing out that bullies and "hard-boiled" individuals are at heart cowards and weaklings. While it is unsafe to generalize too freely about the traits of human nature, Adler believes that his clinical evidence supports his theory.

In the examples of compensation just mentioned, the individual escapes from his feeling of inferiority by the simple device of assuming superiority. Of course he does this unconsciously, in the sense that he is not aware of his own motives. Numerous instances of this method of compensating abound in both normal and abnormal motivation. The individual who

has amassed a fortune by squeezing money out of others compensates by contributing generously to churches and other worthy institutions. This appeases his conscience and enables him to feel virtuous. Again, the mediocre student finds solace in the fact that he is not a "grind." Even if he does not make good grades, he is superior socially; and of course social superiority is the only kind really worth while. Curiously enough the "grind" himself, in all likelihood, is compensating by an identical method; he is interested in the "higher" things of life, and is really inferior in one unessential respect. An interesting and common manifestation of this attitude is found in the way in which students account for their good and poor grades respectively: they "make" good grades, but the instructor "gives" them the poor grades. Doubtless the principle of compensating for inferiority by assuming superiority can be easily over-worked, but it seems applicable nevertheless to numerous acts of everyday behavior.

The terms *sublimation* and *transference* express methods of compensation which are recognized by Adler and by most psychoanalysts. Without attempting to analyze these terms in detail we may note that they involve the principle of conditioned responses. The classic example of the psychoanalysts is that of love which for some reason does not find a normal outlet. When so repressed, it can be centered upon pets, novels, poetry, moving-pictures, gossip and scandal. Undoubtedly, many people derive a vicarious satisfaction of their sentimental emotions from such sources. Other people have imaginary love affairs with celebrated characters, especially moving-picture actors. Repressed impulses which are redirected upon socially accepted situations are said to be *sublimated;* those which are redirected from one definite object to another are *transferred.* While these facts are explained by the psychoanalysts in mysterious and metaphysical terms, they are patently instances of substitute stimuli. They are actually accounted for by the principle of conditioned responses. Adler

differs from other psychoanalysts in viewing sublimations and transferences as expressions of the inferiority complex. As he would say, even love reflects the prestige motive, since the ideal lover is invariably *superior*.

The Motive of Doing Things for Their Own Sake. Several writers are in full sympathy with the popular view that an interest in *accomplishment* is very often the determining motive in conduct. The sociologist Veblen has stressed this view in his book, *The Instinct of Workmanship*. As his title suggests, he holds that the artistic impulse, or the desire to do things and to do them well, is a fundamental inborn human trait. And Woodworth (32) summarizes his discussion of the topic in the following statement: ". . . almost any object, almost any act, and particularly almost any process or change in objects that can be directed by one's own activity towards some definite end, is interesting on its own account, and furnishes its own drive, once it is fairly initiated."[1] Whether it is called art for art's sake, the creative impulse, or something else the existence of the trait in question is quite generally recognized.

Before accepting this motive too unreservedly, however, we should examine some of its implications and test some of its applications. For one thing, it scarcely suffices to explain the creation of art forms. In painting, for instance, the artist observes the rules of color combinations and of composition. The juxtaposition of complementary colors is pleasing because it satisfies certain physiological demands in the retina of the eye. And composition includes the principles of balance and proportion, both of which make a direct appeal to our muscles. Moreover, it is reasonable to suppose that the artist is interested in the theme which his picture expresses. If our analysis is correct, many motives and not merely a desire-to-create-something keep the artist at his task. It seems probable, too,

[1] *Op. cit.*, p. 202.

that his joy when he inspects the completed task is due to several factors. The picture may impress him as better than his previous pictures, hence he is pleased at his progress; and he may be relieved because his task has been slightly irksome. In other words the motive of doing things for their own sake, like the "instinct" of self-preservation, is more complex than its name suggests.

It is also possible that this motive is socialized to a greater degree than is ordinarily assumed. Granting its existence in the artist, we may wonder if it would be effective without a social background. While he may genuinely shun publicity and abhor popular fame, the artist nevertheless expects his picture to be seen and appreciated by some individual or group of individuals. Again we must avoid hasty generalization, but we may well believe that the number of pictures that are painted and books that are written would be substantially reduced if they were doomed to total and permanent obscurity.

On the other hand, accomplishment for its own sake seems to be probable on physiological grounds just to the extent that the activity involved is relatively simple. In one sense of the term, muscular exercise is indulged in for its own sake. By the same token, people see, hear, and touch things for no reason save that the active functioning of the receptors is spontaneous. Such activities are most adequately explained in terms of physiological metabolism; when anabolism exceeds catabolism, spontaneous activity is the direct physiological result; or in plainer language, an excess of energy means "pep," with its resulting spontaneous activity.

Social Motives Reduced to Tissue Needs. We are now prepared to see that social motives are expressions of physiological conditions. As regards visceral functions, the tissue needs of the body seem to be either metabolic deficiencies, such as the need for food, or changes in the tonicity of visceral structures caused by exteroceptive stimuli. In either case, these needs give rise to *tensions* which are reported in consciousness

and known as desires. Just as food satisfies the visceral tension called "hunger," so a passing grade in a course relieves the visceral tension called "worry." Both the food and the grade are *tension-relieving* stimuli. Likewise the desire for money or for social recognition may be thought of as a tension, existing chiefly in the visceral system. If sufficiently intense, such a desire may be physiologically "painful." Certain objects or situations produce, rather than relieve, these tensions. The sight of food may arouse hunger, and the sight of a new model automobile may arouse (or create) the desire to possess it. These are *tension-producing* stimuli. Some integrative process (conditioning, for example) is responsible for such social stimuli as either produce or relieve tensions. And we must not overlook the fact that our social responses are conditioned largely upon words. If either the sight of food or a verbal description of food may arouse hunger, it is reasonable to suppose that the two stimuli are physiologically similar.

After all, no sharp distinctions exist between physiological and social human motives. In any concrete activity, say the act of eating, the two are blended so intimately that they can be separated only for purposes of scientific analysis. All human physiological drives and emotions are socialized, and conversely, all social motives are ultimately biological. The first statement has been sufficiently explained throughout our discussion. The second becomes evident when we realize that social motives provide for the welfare of the organism in which they are manifested. Individual superiority is biologically useful, hence the prestige motive prompts the individual to make the adjustments necessary for his welfare. The biological significance of social customs is illustrated by the fact that in general they provide for the satisfaction of physical wants. The perfect host is indeed the one who makes his guest comfortable. It is true that fashion frequently dictates the wearing of uncomfortable shoes, but taken by and large, social

custom sanctions cleanliness, physical well-being, and personal comfort.

Pleasantness and Unpleasantness

Feeling, or more properly affection, is the term used to designate states of pleasantness and of unpleasantness. According to the traditional and commonly accepted view, there are degrees of both, and there is also an intermediate, neutral state. It is therefore possible to represent all affective states by a straight line, one end of which represents maximum pleasantness, and the other, maximum unpleasantness, with the neutral point in the middle.

Most psychologists hold that affection should be distinguished from emotion, on the one hand, and from sensation, on the other. According to Titchener, affection is an elementary mental process, incapable of being analyzed into other elements. It is not emotion, for emotion contains sensory elements. A given emotion seems to be either pleasant or unpleasant, depending upon its intensity and upon the person who experiences it. Many people report that they enjoy the state of anger. Mild fear, such as that occasioned by riding on a roller-coaster, is pleasant, while intense fear, with normal people at least, is uniformly unpleasant. Then, affection and sensation are variables in consciousness. One enjoys the first piece of candy more than he does the tenth, although the gustatory qualities of the two are theoretically the same. Unpleasantness resembles pain so closely that the two are frequently identified. Introspectively, however, the unpleasantness of grief and that of a toothache differ from each other. We may conclude, therefore, that pleasantness is a conscious quality which may be abstracted from such varied complex experiences as eating candy, swimming, seeing one's favorite actor at the cinema, smoking, receiving an unexpected gift of money, traveling abroad, having one's first novel accepted by a publisher, building Castles in Spain, and being flattered

Conversely, unpleasantness for most people is common to a toothache, bad news, being bored, morbid thoughts, receiving a social snub, and tasting rancid butter.

Affective experiences have one introspective characteristic that distinguishes them from all other conscious states: they tend to disappear when one directs his attention to them. As Titchener (29) describes this characteristic, they lack the attribute of clearness. Attend to the gustatory sensations occasioned by eating candy and they become clear; try to notice the pleasantness, as such, which accompanies these sensations and it eludes you. To quote Titchener, "If we want to get pleasure from a concert or a picture, we must attend to what we hear and what we see; so soon as we try to attend to the pleasure itself, the pleasure is gone."[1]

Wundt's Tridimensional Theory of Feeling. The German psychologist Wilhelm Wundt, who in 1879 established the first psychological laboratory, was one of the first investigators to propose a theory of affection. While his theory is now primarily of historical interest, it illustrates the problem of the introspective analysis of affective states. Wundt found three pairs of affective elements in consciousness; namely, pleasantness-unpleasantness, strain-relaxation, and excitement-calm. The members of the respective pairs are thus antithetical and opposed.

Wundt's analysis has not been generally accepted. The American philosopher Royce pointed out that the strain-relaxation element was not an affective consciousness, but rather an experience consisting of kinesthetic sensations. Titchener added to this the criticism that excitement and calm also were reducible to kinesthetic experiences. And Woodworth (34) suggests that a classification of paired and opposite feelings should include desire-aversion and familiarity-strangeness.[2] Wundt's scheme is perhaps too formal and too simple.

[1] *Op. cit.*, pp. 231-232.
[2] *Op. cit.*, p. 283.

Are Pleasantness and Unpleasantness Exact Opposites? In a recent article, Cason (10) takes exception to the traditional account of pleasantness and unpleasantness. He states his inability to distinguish between the sensation of pain and the feeling of unpleasantness. He further contends that pain (or unpleasant experience) is more positive than pleasure, more insistent, and more effective as a motivating factor. "The fact," states Cason, "that there are no pleasures that are nearly as pleasurable as some pains are painful can be illustrated by Schopenhauer's suggestion to compare the respective feelings of two animals when one of them is eating the other."

Pleasantness and Unpleasantness as Motives. The layman does not care whether happiness and unhappiness, pleasantness and unpleasantness, pleasure and pain, joy and despondency are "mental" or "physiological" as regards their ultimate nature. He believes that they make life worth living or not, as the case may be. Naturally, he is correct.

Possibly we can show a relationship between his belief and certain fundamental biological and physiological principles. Clearly, pleasantness is related to tension-relieving stimulation and unpleasantness, in turn, is correlated with tension-producing conditions in the organism.

Troland's Theory of Retroflex Action. Herbert Spencer assumed that pleasantness and unpleasantness are correlated respectively with beneficial and harmful forms of stimulation; for otherwise, according to his conception, the organism could not survive. As a biological teleologist, Spencer based his arguments primarily upon biological rather than physiological considerations.

Troland (30) takes this general conception as the point of departure for his theory of retroflex action. All stimuli acting upon the organism produce effects which are physiologically harmful, beneficial, or neutral. Furthermore, since stimuli have been affecting the organism in these three ways throughout the entire evolutionary process, it has developed

receptors or sense organs and corresponding brain mechanisms which react to such stimuli in the way best calculated to serve its needs.

As described by Troland, the *nociceptive* system of sense organs and brain connections responds specifically to stimuli which are injurious to the individual organism or to the species; and nociceptive stimulation, as reported in consciousness, is unpleasant. Pain is the most specialized nociceptive sense, but any receptor system which arouses pain is nociceptive provided that it injures the tissues in which its receptors are embedded. Most of the appetites or cravings, such as hunger and thirst, are nociceptive. Of the four tastes (bitter, salt, sour, and sweet) the first three are nociceptive. In general, all forms of excessive stimulation are nociceptive.

The *beneceptive* system gives rise to pleasurable states of consciousness. Since food is of fundamental importance to the organism, Troland stresses the rôle of the *saccharoceptive* system (that is, the taste organ for sweet substances and its neural connections) in the organism's food-securing activities. Some odors and certain intensities of erotic excitation are also beneceptive in function.

The *neutroceptive* system tends to correspond with the distance senses. Unless otherwise influenced by learning, vision and audition are neutroceptive; the former, for example, ". . . picks up the picture of a sweetheart, or of a ferocious animal, with equal facility, and it also records equally well a perfectly meaningless pattern, such as a seismograph record." [1] Touch (excluding pain and temperature) is neutroceptive. A neutral feeling or affective reaction, of course, accompanies stimulation of a neutroceptive system.

But the correlation between anatomical organs and the three effects of stimulation is imperfect. Nociceptive and beneceptive stimulation report the metabolic condition of the organism while neutroceptive stimuli report facts about the environ-

[1] *Op. cit.*, p. 208.

ment; but the relationships between the organism's environment and its internal condition are complex. Thus, nociception and beneception apply only to *average* biological values. The saccharoceptive system, for example, responds to acetate of lead, a deadly poison, as well as to other sweet-tasting substances which are beneficial; but, "If evolution had been compelled on the average to deal with acetate, the saccharoceptive process would have to be classed as nociceptive rather than as beneceptive." [1] It will be recalled that this general principle was emphasized in our discussion of purposive behavior. Troland points out that the intensity and the duration of the stimulus help determine its classification as beneceptive, neutroceptive, or nociceptive.

Troland uses "retroflex action" to designate the after-effect or "back-kick" of stimulation: nociceptive stimulation *inhibits,* while beneceptive stimulation *facilitates* cortical processes, thereby inhibiting or facilitating overt behavior. When, for instance, the child happens to touch a candle-flame, its reaching responses are inhibited by the nociceptive brain mechanism set into action by the pain stimuli. Conversely, when it reaches for candy and places a piece in its mouth, its motor responses are facilitated.

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CHAPTER V

THE LEARNING PROCESS

The term *learning* covers the multitude of acts, thoughts, meanings, and habits that the human or animal acquires in the course of a lifetime. The human learns to dance, manipulate tools, catch a ball, plant a garden, fire a gun, drive an automobile. He learns to acquire language habits; that is, to understand the meaning of words, to speak them, write them, and read them, to arouse meaning in others by gestures and facial expressions, and to understand the meaning of such gestures and expressions when stimulated by them. He learns the nature and properties of objects that surround him—the hardness of rocks, the softness of the turf, the painfulness of fire, the sweetness of candy, and the tonality of musical instruments. Nearly all animals are capable of learning. The earthworm, after a prolonged "trial and error" period, learned to turn away from a "painful" stimulus and to crawl towards food. Even the behavior of certain one-celled organisms is modified through experience.

Learning and Memory. A perusal of the foregoing list of examples of learning shows that any acquired modification of behavior, as opposed to modification due to physiological maturation and growth, is to be classified as learning. From this point of view, learning is a broader term than memory as that word is employed in daily speech, although they are frequently used interchangeably and with a variety of meanings. A man may have a splendid memory and yet not be a learned man, while another may have a poor memory and still be rated as learned. Used in this way, the word *memory* refers to the ability to reproduce material more or less in its original se-

quence, and the word learning refers to the profundity and breadth of ideational acquisitions. We memorize a speech, but learn a dance-step. A violin selection is played from memory, but a drop-kick is not executed from memory. The individual executes it because he learned it, not because he memorized it. And yet all of these uses of the two terms have one thing in common: the effects of experience persist over an interval of time and become observable through the changes they introduce in the individual's repertoire of reactions. This persistence over an interval of time is spoken of as *retention,* while the production of that which is retained is referred to as *reinstatement,* or in the case of verbalized material, it is referred to as *recall.* In general, whenever retention is mediated by verbal symbols we speak of memory, otherwise of learning and remembering. Or to state it more accurately, we use the words "to learn" or "to remember" wherever we also employ the words "memory" or "to memorize." But the reverse does not hold true. We do not "memorize" how to operate an automobile, although we may "learn" and "remember" how to do so. Yet if such learning were facilitated and controlled by means of words or language symbols, we should speak of memorizing the operation, just as we speak of memorizing a musical composition. Psychologically, all such acquisitions, whether involving muscular skill or verbal controls, are phenomena of learning. The supreme importance of language in the life of man is responsible for its separate consideration under the caption of memory. Psychologically there is no sharp break between learning as such, and memory as such.

The Experimental Study of the Learning Process: Results and Interpretations

Animal Learning. One of the favorite animals used in the experimental study of the learning process is the white rat. Its normal life span is about three years and as a consequence it matures rapidly and in this way lends itself to facile control.

Incidentally, the further fact that it is a prolific animal makes the study of the possible inheritance of learning capacity more amenable to experimentation. In connection with our discussion of the mechanism of learning, it will be necessary to give a somewhat detailed review of some of the work done on this animal. An understanding of this work is essential to an understanding of existing views of the nature of the learning mechanism. In the course of our review of experiments on the white rat, we shall find it advisable to consider some of the experimental work in which other animals were employed. This preliminary survey of learning experiments with animals will not only serve the purpose of rendering the problem of the mechanism of learning intelligible, but will at the same time give a better and deeper understanding of the nature of learning itself. In addition it will fortify our grasp of the scientific method employed by the psychologist in the analysis of his problems and in the technique he devises in solving them.

When endeavoring to determine the manner in which an animal learns, psychologists place the animal in a situation that necessitates a realignment of inherited behavior mechanisms before particular organic needs can be fulfilled. For a rat to nibble at and swallow a piece of food placed in front of it does not indicate any learned reaction. The food response is manifested by the new-born animal. In reacting to the food, it is supplying one of its organic necessities. If the food, instead of being placed in front of the rat, is concealed in a compartment of the cage that can be reached only by means of an indirect and devious path, the animal must first solve the problem of finding the correct pathway before the particular organic need—in this case hunger—can be satisfied. A study of the consequent behavior furnishes an opportunity of examining the way in which organisms solve their problems. Learning is evident wherever an old situation is handled in a new way or where a situation that could not be handled in the beginning is handled at the end. By arranging such situations

and systematically recording the resulting behavior of the animal, psychologists have amassed a large body of information concerning the nature of learning reactions.

The Maze Experiment: Early Investigations. The psychologist Watson (29) placed white rats in a specially constructed box known as a maze. As has already been mentioned, and as is indicated in Figure 19, the maze consists of

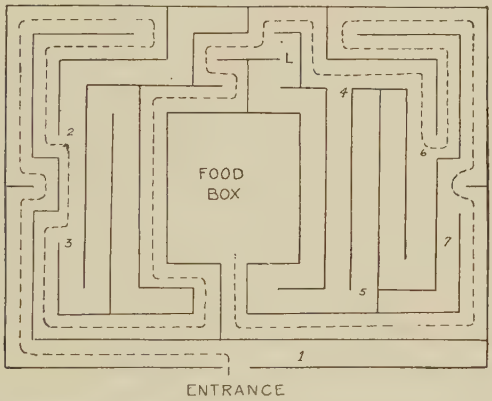

FIG. 19.—Diagram of the Hampton Court Maze. (After Watson.)

The true path to the food box is shown by the dotted line. Blind alleys are indicated by numbers. The letter L indicates an alley that leads to the food by a longer route. As designed for Watson's experiment with rats, the alleys were 4 inches wide and 4 inches high. All parts were made of wood ⅞ of an inch thick. The top of the maze was covered with wire netting. The maze as employed in this experiment was 5 feet wide and 7 feet long. This makes the distance from the entrance to the food box, indicated by the broken line, 40 feet long.

a series of tortuous runways along the floor of the box, formed by inserting vertical partitions, that communicate with each other. Some of them connect up in such a way that when followed they lead to a central compartment in which food is placed. Others radiating out of those are in the nature of blind

alleys or culs-de-sac. As far as the rat is concerned, the problem-situation is comparable to that which might confront a famished man shoved into a vast house built like a modern department store, except that the various rooms are arranged in helter-skelter fashion. The efforts of the starving man to find his way to the kitchen would be analogous to the efforts of the rat to find its way to the food box. We shall revert to this analogy presently.

For the time being let us consider the behavior of the rat. When first introduced to the new situation, the animal runs hither and thither, doubling on its tracks repeatedly, going in and out of blind alleys until chance directs it into the final runway that leads to the food box. The entire time required to secure the food is almost half an hour. In the process every part of the maze is traversed, and the total distance covered by the rat may have been about 3,600 feet, when the minimum distance from the entrance of the maze to the food compartment is but 40 feet. This enormous excess of movements together with the evidently accidental nature of the final entrance into the successful path indicates that the rat cannot be said to have *solved* the problem, if that term is intended to connote reasoned analysis. To ascertain whether the animal can profit at all from this experience, it is placed back into the beginning part of the maze on repeated occasions. If on these subsequent trials the time required to reach the food box and the distance traversed is reduced, the possibility of such profiting is demonstrated. As indicated in Figure 20, it has been found that after thirty such trials the rat will scamper along the appropriate alleys in approximately half a minute. That is, it will confine its movements to just those paths that will get it to the food as quickly as possible. It will limit itself to the 40 feet representing the shortest distance from the entrance to the feeding place. This reduction in time required and the distance covered came gradually in the course of the thirty trials. There was no precipitate reduction such as we find

when we suddenly see into the principle of a problem in mathematics. In the sense that the rat finally responded to the problem-situation in an expeditious, efficient manner, it may be said to have learned the situation.

The Rôle of the Sense Organs in Maze Learning. Watson undertook the task of first determining whether vision was

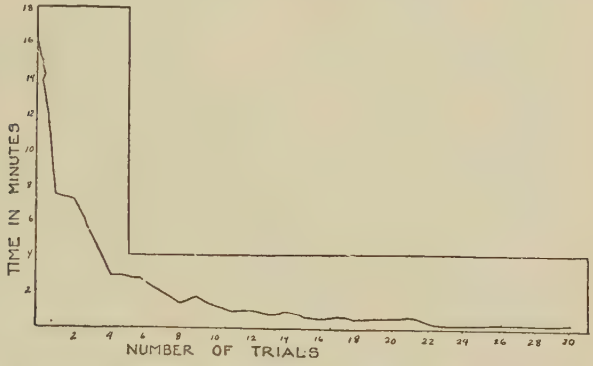

FIG. 20.—Learning curve showing the average time per trial for 19 normal rats. (After Watson.)

Note the slope of the curve indicating the gradual, as opposed to sudden, mastery of the maze. The flat stretch of the curve for the last five or six trials may be regarded as illustrating the approach to the physiological limit. In this case the physiological limit would be approximately 20 seconds for the 40 feet of the true path to the food box.

essential to the learning by finding out whether rats could thread their way in the maze in darkness as well as in the light. The results of this test showed that absence of light did not interfere with the successful execution of the performance, the animals negotiating the maze as quickly in the dark as in the light. This did not prove that vision was unessential in *learning* the maze. To demonstrate the latter it is necessary to place untrained rats in an unilluminated maze and record the resulting behavior. If they succeed in mastering the pathways as quickly and effectively as those trained in the light, the case

for the dispensability of vision will be strengthened. Actual tests showed that such untrained rats succeeded in learning the maze in normal time, despite the fact that they were deprived of visual clews. However, the criticism might be made that the darkness was not absolute and that faint visual stimulation may have guided the rats. To forestall this objection, Watson went one step further and repeated his experiment with two groups of rats whose eyes had been excised by means of a surgical operation. One of these groups had been trained in the maze and the other group had never been subjected to the maze situation. According to the experimenter (29), "the trained group of blind rats ran the maze with only a slight loss in efficiency which might have been predicted when we recall the fact that after the animals had been operated on, they were not again tested in the maze until 40 days had elapsed; consequently there was a slight loss of retention." [1] He found further that the wholly untrained but blinded rat learned to run the maze in the standard time. In this way he demonstrated that the eyes are not needed at all, either in the establishment of the learned performance or in regulating its execution after it is learned.

By dissecting out the olfactory bulb, Watson found that the resulting loss of olfactory impulses did not militate against the learning, the behavior being in every way like that of the normal rats. They too succeeded in the dark maze as well as in the light. With two receptor mechanisms disposed of the matter was not yet settled. It might be that the animals learned as a result of auditory stimulations reproduced by the faint sounds made when their feet came into contact with the floor of the maze—that they learned to locate different parts of the enclosure by slight differences in sound, just as we can tell whether a man is walking on a boardwalk or a stone pavement. This possibility was dismissed when it was found that animals whose hearing mechanism had been surgically inter-

[1] *Op. cit.*, pp. 213-214.

fered with accomplished the task of mastering the maze in normal time.

As is well known, the rat possesses rather prominent "feelers," or vibrissæ as they are called. Among other things it remained to determine the part played by these vibrissæ in learning. Cutting them off failed to make any difference in the performance of those rats which had previously been trained (provided they were given a few days in which to recover from the effects of the operation), nor did it prevent untrained rats from responding to the training in the standard way. To ascertain whether the animals were aided either by temperature variations or by air currents within the maze, Watson deliberately modified the temperature and shifted the air circulation without producing any change in the rats' ability to run the course. He also ruled out the possibility of direct contact by anesthetizing the snout and bottom of the feet. Such disturbances of contact sensitivity failed to produce a retardation, diminution of time, or other observable interference of maze learning ability.

The only relevant remaining system of receptors is that of the proprioceptive system, in particular, the kinesthetic receptors of the kinesthetic system. These receptors, it will be recalled, are found embedded in the muscle tissue and in the tendons as well as on the joint surfaces. Whenever movement takes place they are automatically stimulated. Movement is controlled and perceived (apart from vision) largely through such stimulation. Having failed to account for the rat's maze learning on the basis of vision, smell, hearing, the various forms of contact and so forth, Watson concluded that the learning proceeded by means of this one remaining receptor system.

He constructed a maze that could be adjusted in such a way that the length of the different parts could be altered without changing the general relation of the parts to each other. In this way he could train one group of rats in a maze that had short pathways and another group in a similar maze that had

long pathways. If the animal depends primarily on its kinesthetic system for guidance through the maze, then any alteration in the dimensions of the maze should interfere with the execution of habits established in a maze of different size. Reasoning in this way, Watson trained one group of animals in the shortened form and after the learning was completed he placed them in the maze for whose dimensions they presumably had no kinesthetic clews developed. His expectations were realized: those rats which had been trained in the shortened form tried to make the turns too soon when placed in the lengthened form, while those which had been trained in the lengthened form over-ran the alleys when placed in the shortened type of maze. The kinesthetic impulses or proprioceptive stimuli were thus demonstrated to function as the principle guides in this particular experiment.

In connection with this phase of his conclusion, Watson states that "one objection has been raised to the resolving of the maze habit process into the functioning of a serially chained kinesthetic system. It may be stated as follows: in man and in animals kinesthetic arcs function in perfect habits until some disturbance occurs, *i.e.,* until rival impulses coming in over other receptors become sufficiently strong to produce inhibition of the customary movements. It is held that a similar situation exists in the case of the rat in the maze. The animal may be automatically traversing the maze at a high rate of speed when suddenly a loud noise, a strange odor, or an intense itching occurs. The chain of movements is broken. How does the automaticity become reëstablished? The human being under similar circumstances—when momentarily lost while executing a purely automatic habit—remains unoriented until supplementary distance sense data are at hand; *e.g.,* he glances at the score if playing a piece of music. These reactions at hand, the reign of kinesthetic arcs is reëstablished and the automatic character of the acts again becomes apparent. But in the case of the rat do distance sense data function in this

way? We conclude, on the basis of a large amount of experimental work, that automaticity is reëstablished for the rat solely from the distinctive kinesthetic impulses which function exactly as do the visual impulses in the case just stated for man. If the trained rat is put down in a part of the maze other than the entrance, he runs at first randomly. He may wander about, turn round and round in the alleys, but suddenly he darts off and traverses the remainder of the maze in the usual automatic way. We hold that during the period of random activity the animal passed over what we may call a 'kinesthetic unit,' thereby arousing a certain sequence of kinesthetic impulses which could not be aroused in any other part of the maze. This distinctive group of impulses is sufficient to reëstablish automaticity." [1]

Some Further Considerations. In the rather extended description of the experimental procedure resorted to by Watson, we have a good illustration of the way in which the psychologist attacks his problems. On the basis of the results obtained it is clear that maze learning in the rat is largely a matter of kinesthetic integration. The question of the function of the other receptors might be raised. Of what use are eyes, ears, vibrissæ, if the animal can learn as effectively without them? Or does the finding of Watson apply exclusively to the maze situation? It is interesting to note that both Vincent (27, 28) and Carr (2) have shown that Watson's results are not to be regarded as having universal application. The former investigator demonstrated by means of appropriate modifications of the maze conditions that contact, olfactory, and visual receptors can be made to play an effective part in the learning. Carr has verified and amplified Vincent's results to the extent of showing that there are numerous individual differences in the degree to which rats are affected by the loss of given receptors. He also showed maze learning to be dependent upon a variety of factors that at first sight might ap-

[1] *Op. cit.*, pp. 217-218.

pear to be unrelated to such learning. For example, the position of the experimenter during the trials, rotating the maze itself, and changing the position of the cage in which the rats were kept between trials were all shown to influence maze mastery. His data also indicate that with respect to some of these factors, loss of vision is advantageous in the learning while it is a handicap in other respects.

Such findings do not necessarily imply a flat contradiction of Watson's results. They indicate rather that care should be exercised in the interpretation of the work of Watson as referring to the conditions prevalent during his experiment and to the particular animals he employed. Carr's investigation and Vincent's results are not a refutation of the earlier findings that the fundamental receptor system involved in maze learning is the kinesthetic. As Carr points out: "The work of Watson, Bogardus and Henke, Vincent, *et al.* has shown that the white rat learns the standard type of maze primarily in tactual and kinesthetic terms, that during the learning the control is gradually transferred from contact to kinesthetic, and that after the problem is thoroughly mastered the act is to be regarded as a kinesthetic-motor coördination with an occasional reliance upon contact in time of emergency." [1]

We must understand Watson's results to mean that under his experimental conditions, loss of exteroceptive cues made for no measurable handicap in the rat's maze learning ability. This is not the same thing as saying that the rat does not use them when they are present. It would be rash to conclude even on the basis of Watson's experiment considered separately that eyes, ears, vibrissæ, and other exteroceptors are of no functional significance to the rat when confronted with the maze problem. All we are justified in concluding is that so far as maze learning under his experimental situation was concerned, their *loss* was not a serious handicap. An illustration may possibly be of service in clarifying this point. Let us as-

[1] *Op. cit.*, p. 259.

sume that we have a shelf of books containing volumes of different types of bindings. This shelf represents our working library—we have been using these books for years and are thoroughly familiar with their location. We then have a friend measure the speed with which we can take out any book he names. In this way we take out ten books, always replacing the one we have removed after the time has been recorded. This will give us the average time of location and removal of a book. Now if this test should be conducted in daylight, then repeated when the room is pitch black and the average time in both instances is found to be the same, the conclusion that vision plays no part in the test conducted in daylight would be unjustified. Such a test merely demonstrates that when confronted with the necessity of dispensing with vision we can get along by means of the tactual and kinesthetic receptors without demonstrable handicap.

The Problem Box Experiment. While much information concerning the learning ability of animals has been accumulated by the use of various types of maze with different species of animals (including man), much additional and supplementary information has been obtained by means of other experimental devices. One of these that has been particularly fertile in its results is known as the problem box experiment (Fig. 21). This experimental method, introduced into animal psychology by Thorndike, has also been tried out on a diversity of animals, including such species as birds, rats, cats, dogs, raccoons, and monkeys. While the technique differs, depending on the animal species, its essential principle is that of placing the animal in a problem-situation that can be solved by means of manipulating some mechanical locking device. A hungry animal is locked inside a cage-like box and food is placed on the outside in sight of the animal, or else the food is placed inside and the animal outside. In order to get the food, it is necessary for the animal to "solve" the locking device. The solution may involve pulling a string attached to a latch, open-

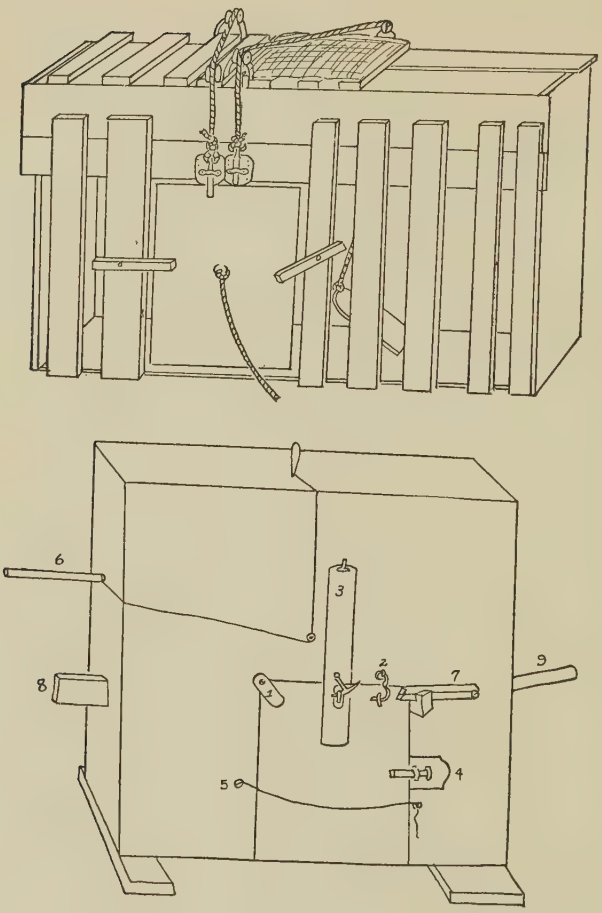

FIG. 21.—Two problem boxes employed in experiments on animal learning. The upper box has been used in experiments on cats and the lower one in experiments on monkeys. The sequence of operations required to open the latter box is indicated by the numbers.

ing a spring door by tearing off strips of paper holding it in place, turning a button, locating an opening at a given part of the box by removing a pile of sawdust concealing it, and so forth. Having secured the food, the animal is put back on repeated occasions to see what effect the previous experience will have on its later behavior. Like the maze experiment, it is intended to reveal the extent to which the animal can profit by experience. In terms of our previous analogy of the starving man lost in a department store, the situation is similar to the experience that would be his, if upon reaching the restaurant, he should find the door bolted with a combination lock. Or else we might compare it to the behavior of a person on a "treasure hunt."

When confined in the problem box, the animal, such as a cat, reacts to that situation by attacking the different features of the enclosure in an impulsive, unsystematic, try-try-again manner. It scratches, claws, bites, pushes, tugs now at this slat and now at that, shifting from one wall to the next until eventually the correct reaction is made and the food secured. Upon successive trials the animal gradually dispenses with the useless movements until, finally, its reaction is limited to the part of the box regulating the locking device and its movements are limited to those necessary for securing release. The number of trials required for the animal to attain this degree of competence gives a measure of its learning ability. The behavior manifested in the process might be compared to that of the man trying to get into the restaurant when he bangs and pulls at its door, kicks it, turns the knob to the right and left, pushes and pulls it, until in the course of these random reactions he accidentally hits upon the precise combination of movements that results in the door swinging open.

Human Learning. The use of language gives humans a tremendous advantage over animals in the mastery of problems that beset living beings. Part of this advantage comes from the fact that written records and oral tradition enable

each succeeding generation to use the solutions of previous generations. The new generation can start where the old left off. To the extent that animals are unable to employ language data in the way man employs them when he reasons out a problem, animals lack the use of man's chief instrument of thought. But is there not an analogous or substitute mechanism by means of which some of the higher animals, at least, can deal with their environmental difficulties in a way that involves something of the nature of reasoning? Another way of putting the same question is to ask whether humans attack their problems in a way similar to the method employed by animals. Is there a peculiarly and exclusively human way of solving problems?

The Maze Experiment with Humans. In studying maze learning in humans, psychologists usually employ what is known as a pencil maze. This consists of a miniature animal maze whose pathways are traversed by a pencil or stylus held in the subject's hand. The pathways are made by cutting grooves through a sheet of metal or a piece of board. During the entire course of the learning the subject is not permitted to see the maze, being either blindfolded or compelled to "feel" his way through a maze that is concealed from view by a canopy of dark cloth. By thus limiting his direct sensory experience to tactual-kinesthetic cues, the situation is rendered more comparable to that which such an animal as a rat undergoes in the maze.

Of course it may be argued that guiding the hand through a maze is not analogous to guiding the body through one. However, to construct a large enough maze for an adult to use involves too much expense and would consume too much laboratory space to render experimentation of that sort readily feasible. Furthermore, it has been shown that the pencil maze is sufficiently like a genuine "life-sized" maze to render the results comparable. Some years ago the writer (16) in a study of human maze learning obtained the use of a maze

located in one of the Chicago amusement parks. This maze, called the "Mouse-trap," was admirably suited to the purpose, being close to 150 feet in circumference and so arranged that from an elevated platform the experimenter was able to observe and note down each significant move made by the subject. Comparative studies of the results secured from such a maze and from pencil mazes of several different patterns indicated that the human learning process in the maze was not a different process in the two types of mazes. There were certain differences in the results, but these were shown to be due to differences in the *patterns* of the mazes employed, rather than to the different physical reaction called for. Accordingly, we are fully justified in resorting to the pencil maze technique in investigating the process of human maze learning for purposes of comparison with similar learning in animals.

The pattern of one of the pencil mazes employed in this study was practically a replica of the one used by Watson in his investigation. To that extent the findings are more comparable than would be the case if the patterns were different. Since the subjects were adults with intensive training in psychology, the verbal description of their learning experience is particularly suggestive, and it furnishes us with an instructive and relatively reliable picture of the "inner" side of such learning. This does not mean, however, that we may legitimately infer that such a picture is also representative of what the rat probably experiences in learning a maze. The observable behavior is all that lends itself to reliable comparison.

As is to be expected, there was neither an absolute uniformity of verbal report nor of behavior in the case of these human subjects just as there is not absolute uniformity in the behavior of animals. Men as well as rats show individual differences. However, just as there was sufficient identity in the general behavior of Watson's rats to permit the formulation of a composite conclusion regarding their learning, so in

the case of humans learning a pencil maze a general account of the process is possible. On the side of behavior it was found that the early trials of the subjects "consisted in a seemingly aimless trying-out of paths that offered themselves, a performance that strongly suggested the efforts of a newly-caught animal to escape from a pen." This initial exploratory behavior was followed in the succeeding trials by more activity along the true pathway. Accompanying this, of course, was a reduction in the frequency of entering blind alleys as the learning progressed. The blind alley was not recognized as one until the subject was obstructed in his progress by coming into contact with the blind end. Another general tendency that the experiment revealed was the inability of the subjects to profit by a single cul-de-sac experience. The same cul-de-sac would be repeatedly entered for several successive trials. It might then be avoided for a few trials, only to be reëntered in one of the later trials. Such trial and error behavior was manifested not only in the culs-de-sac, but whenever the subject became confused, even in the true path.

The introspections or verbal reports of the subjects showed that they attacked the maze problem with the intention "to develop an ideational control over the maze," to get an "image" of it. The various parts of the maze gradually became familiar in the course of the trials as a result of three chief elements:

a. Associating different positions of the arm with different parts of the maze. The arm might be extended in one part and flexed in another.

b. Differences in kinesthetic experiences as the arm was moved along different lengths and in different directions.

c. "The image scheme of the maze, as checked up by these various sense factors."

The last statement indicates that it was the sensory experiences coming from actual active investigation of the maze that was fundamentally operative in bringing about mastery. As in Watson's work, the cutaneous and kinesthetic cues were of

basic importance. While the subjects approached the maze problem with the advance information that it was a maze (information that in the nature of the case rats could not be presumed to possess), and while, further, they tried to handle the problem rationally, their general handling of the situation was not outstandingly different from that of the animals. The reasoning indulged in was neither systematic nor effective. "Adequate interpretations were suggested to the learner as the result of prolonged exploration, rather than reasoned out. Cues which logically should be utilized for correct inferences were disregarded, and ideas were acted upon in an uncritical manner until they were proven by trial to be incorrect. The explanation of the meager attempts at reasoning is to be found in the fact that the learner had no past experience to apply to the situations, and in the fact that he was unable to select his data —maze paths must be traversed in order."

Since on the basis of the introspections the subjects utilized such devices as memorizing the sequence of pathways in the simpler maze situations, and studying the situations in more complex cases, it cannot be maintained that pure "trial and error" characterized the learning method. It is even more certain that "pure reason" or "ideational learning" is totally inadequate to describe the method. If we were to ignore the introspections and limit the interpretation to the observed behavior during the progress of the learning, then whatever interpretation we have to offer for animal maze learning would serve to account for the manifest aspects of similar learning in humans. Neither the observed behavior nor the learning curves showed any radical difference in the manner of mastering this kind of situation, under the given conditions. To the extent that the term trial and error learning describes the behavior of animals in a maze, it also describes human behavior. In the sense that such a term is more descriptive than explanatory, it cannot be said to furnish a satisfactory picture of the underlying method.

Ruger's Experiment with Mechanical Puzzles. The learning procedure of an animal in a puzzle box or problem box was regarded by Thorndike to be completely of the trial and error variety. This kind of procedure is opposed to learning by "insight" or by reasoning. By *insight* is meant that the organism sees into the principle of the problem. It perceives the relation between existing difficulties and the means that must be employed in order to overcome those difficulties. If a monkey confined in a cage, the door of which is fastened by means of a string tied in a bow-knot, should upon its first experience with such a situation immediately attack the knot and after undoing it, glance at the hinges and pull the door in or out, depending upon the location of the hinges, it might be said to possess "insight." It would react as though it perceived the connection between just those features of the situation that were responsible for its confinement and the appropriate measures that must be taken to escape from confinement. In his work with animals in problem boxes, Thorndike was unable to find evidence for the existence of such insight. There was no direct perception of relationships. As a natural outgrowth of this finding, the question arose as to whether humans when confronted with analogous problems would manifest insight or would have to resort to trial and error procedure, or possibly would combine the two.

This was the question that Ruger (18) endeavored to answer. Instead of confining his subjects in problem boxes, he gave them mechanical wire puzzles to solve. The well-known Chinese ring puzzle is an example of the kind he used. He not only observed the behavior of his subjects, but also took the time required for solution and asked for their introspections. In addition, he gave the subjects puzzles based on essentially the same principle, but differing somewhat in construction, in order to ascertain whether the learning of one puzzle would suffice to enable the solution of another by means of an application of the just mastered principle. In general, he

found that trial and error characterized the learning. Simple manipulations that were obviously ineffective in bringing about a change of the parts of the puzzle were repeated again and again. Such "stupid" behavior is not at all unlike that of a cat pawing at the same unyielding slat, or of a rat repeatedly scurrying into the same cul-de-sac. In a few cases the solution was mediated by reasoning, but in the main it was the result of chance. That is, movements which resulted in success were more frequently due to accidental, unpremeditated manipulation than to systematic, intentional manipulation.

It is of interest to note that once such chance success was achieved, the subject on subsequent trials with the same puzzle would endeavor to bring the puzzle around to the same position or place that gave rise to success previously. The place or position became the pivot around which the later efforts swung. Such "place analysis" has also been noted in animal learning. Once having been released from a problem box by manipulating a latch, an animal is likely to focus its subsequent attempts on the latch. It will be recalled that Watson found that a rat dropped into the middle of a maze which it has already learned, scampers around for a short distance and then veers off into the correct direction. Reaction to location or position is thus characteristic of animal as well as human learning. In some puzzles, where the subject had mastered the "principles" as well as the puzzles themselves, he was able to carry these over to related ones. However, when there was not mastery of principle, the new but related puzzle had to be solved in the trial and error fashion just as though there had been no previous experience with that type of difficulty.

Ruger's learning curves for solution of the puzzles often reveal rather precipitate drops. According to Ruger, these sudden decreases in time indicate the presence of insight. They show that the subject has suddenly grasped the principle of the puzzle. In this interpretation he is supported by

Thorndike, who argues that a gradual drop in the learning curve is characteristic of learning of the trial and error variety, while a sudden drop is indicative of learning with insight. Whether such an abrupt descent in a learning curve can be regarded as a criterion of insight, or its absence diagnostic of no insight is open to serious question. To argue one way or the other without additional corroborative evidence is apt to be very misleading. The first part of the learning curve for rats in a maze shows a sudden drop. Does this mean insight? On the other hand, many curves for human learning of such acts of skill as typewriting or telegraphing are more gradual than many of Thorndike's curves for animal learning. In these cases, the absence of sudden shifts in the direction of the curve cannot be explained on the grounds of insufficient insight.

Theories of Learning. So far in the discussion we have been concerned chiefly with experimental results. Throughout the remainder of this section of the chapter, we shall stress the various explanations or interpretations that psychologists have advanced to explain learning behavior. These interpretations are known as theories of learning. It is obvious that *they are theories of integration, or of integrated learning behavior.*

Fact and theory go hand in hand; a fact is interpreted in terms of a theory, while the theory, in turn, suggests additional experimentation, tending to confirm, reject, or modify it. In presenting the important theories of learning, then, we shall introduce new experimental evidence in connection with them.

In the main, theories of learning are based upon studies of animal behavior. But the psychologist assumes that the theory of integration which explains animal learning also explains human learning.

The Frequency-Recency Theory of Learning. We shall now revert to Watson's early studies of maze learning behavior. While they do not express the emphasis upon the conditioning process that characterizes his later work, they deal

with principles which Watson and other psychologists still regard as fundamental. Watson's (30) explanation of learning phenomena stresses the two factors of *recency* and *frequency* of response. As a consequence, his theory is usually referred to as the frequency-recency theory. It represents an application to problems of animal learning of two laws of association that have already been explained. These are the laws of frequency and recency. It will be recalled that according to the former law, "if two or more events have been experienced together with a third one, and if on a subsequent occasion the latter is reëxperienced, then, all other factors being constant, of all the associates with that experience, the one that has occurred most *frequently* will more likely be reinstated than any other." It will also be recalled that the law of recency states that "if two or more events have been experienced together with a third one, and if on a subsequent occasion the latter is reëxperienced, then, all other factors being constant, of all the associates with that experience, the one that has occurred most *recently* will more likely be reinstated than any other."

With these two laws in mind, it will not be difficult to understand the theory of learning favored by Watson. In fairness to him it should be pointed out that he does not regard his theory as a *complete* explanation. While laying principal stress on the factors of *frequency* and *recency* as accounting for the main facts of learning, he also grants that other factors, such as inhibition, reënforcement, and summation of stimuli have a part to play in the process.[1] However, inasmuch as he neglects to use these other factors in his tentative theory of learning, it seems clear that he regards the factors of recency and frequency as pivotal in his theory, and it is on the basis of these factors that it has been severely criticized. The nature of these criticisms will become clear as soon as Watson's conception is described.

[1] *Op. cit.,* Chapter VII.

While many of the students of learning conceive of the underlying physiological changes as being the establishment of new "pathways" in the nervous system, Watson (31) denies the need for such a conception and questions the evidence for it. He maintains that there are more than enough original movements to account for the entire gamut of *learned* movements. All that learning represents is the selection and organization of appropriate, original movements. Such selection

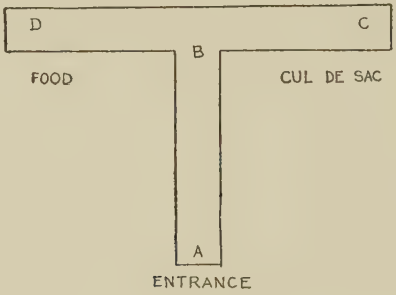

FIG. 22.—A simple T-maze.

makes for the automatic rejection of other movements. There is no necessity for postulating new nervous connections. It is solely a matter of selecting and fixing the useful movements, and the crux of the problem, therefore, is to account for this selecting and fixing. According to Watson's view, all of the animal's repertoire of acts are equally likely to take place at the start of learning; but the law of chance or probability favors those that lead to the goal, provided the animal is kept in the problem situation until it reaches the goal. As a consequence, the movements leading to success will occur more *frequently* than those that lead to failure.

For example, let us assume that the animal is placed in a simple T-maze of the following sort (Fig. 22): The animal is introduced into the maze at A. Since there is but one path from A to B the animal must follow that; but arriving at B

it can go either to the left and get the food at D, or go to the right along the blind alley to C and then double on its tracks and go to D. As soon as it gets to D the trial terminates. The question that confronts us is to explain why after the maze is mastered the animal always goes directly from B to D and not from B to C to D. Watson maintains that the law of probability would give the advantage to the left turn in this case. At the start either the right or the left turn is equally probable, but since each trial ends with the attainment of the goal D, the final left turn *always* takes place, while the right turn need not take place each time. This can be shown by means of a hypothetical series of ten trials made by the animal.

First trial: A to B; B to D.
Second trial: A to B, B to C, C to B, and B to D.
Third trial: A to B, B to C, C to B, and B to D.
Fourth trial: A to B, B to D.
Fifth trial: A to B, B to D.
Sixth trial: A to B, B to C, C to B, and B to D.
Seventh trial: A to B, B to D.
Eighth trial: A to B, B to C, C to B, and B to D.
Ninth trial: A to B, B to C, C to B, and B to D.
Tenth trial: A to B, B to D.

It will be recalled that according to Watson, maze learning proceeds in kinesthetic units. In other words, the right and left turns we have spoken of represent the functioning of kinesthetic units. Inspection of our series of ten trials will show that each trial terminated by a left turn and therefore the *left turn* kinesthetic unit would have the advantage over the right in terms of *frequency* alone. Another characteristic of the situation is to be noted in the fact that since each trial ended with a left turn, such a kinesthetic unit would be the most *recent* one when the animal is returned to the maze for the succeeding trial. *Recency of response* would then coöper-

ate with *frequency of response* to make for the strengthening and fixing of the successful acts.

Criticisms of the Frequency-Recency Theory. The weakness of Watson's view has been brought out by Thorndike (21). Thorndike points out that Watson's theory is inadequate in that it is based on an utterly untenable assumption; namely, that the animal in any given trial will perform each act once only and will then indulge in a different act. We know that a rat will repeatedly double on its tracks in a given blind alley, or that a cat will claw at a particular slat of the problem box many times before relinquishing the unsuccessful attempt. In cases such as these *frequency* should be on the side of the movement that is useless and that is actually eliminated. According to Watson's principle, useless acts would have to be retained along with useful ones. If frequency is a determining factor it might account for the successful attainment of the goal, but it does not account for elimination. In terms of our T-maze illustration, the factor of frequency might account for the animal getting from A to D, but not for the elimination of the movement from B to C. As far as frequency is concerned, the animal might just as likely go to D by way of C as by the more direct route. We have endeavored to illustrate this in our hypothetical series of ten trials by showing that five times the animal traverses the short route and five times the longer, the short route being from A to B and B to D, while the longer route is from A to B, from B to C and then from C to D. In a word, frequency *might* account for fixation of responses, but not for elimination.

In his recent book on learning, Thorndike (22) has this to say about frequency: "Kittens put in a box with bars in the front and one and one-half to two inches apart, the door of which falls open when a loop of wire is pulled, will in the first experience try to squeeze through the opening in the front much more frequently than they will pull at the loop. Yet, at the end of forty or fifty experiences, they will almost always

pull at the loop of wire, rarely or never attempting to squeeze through the openings. There are many, many similar cases." [1]

It might be objected, however, that the factor of *recency* that Watson also recognizes might be sufficient to compensate for any shortcomings of frequency, considered as the sole explanatory factor. In this connection, Woodworth (33) has pointed out that recency cannot be a very potent factor.[2] While he grants that the successful response always completes each trial period and in that sense is the most recent, such recency can only be influential if the succeeding trial takes place immediately. Actually a day often intervenes between successive trials. Very often the response immediately preceding the last one is incorrect. In terms of our illustration, the animal might go from B to C and then from C back to B before making the correct move from B to D. Here the advantage of recency is represented by a difference of a few seconds. If the next trial followed at once, this difference might be an important one; but if a whole day elapses before commencing the next trial, the final successful and most recent response is twenty-four hours old, while the immediately preceding unsuccessful response may be twenty-four hours and a sixth of a minute old. Such a relatively insignificant temporal difference cannot be very important.

These *a priori* criticisms of Watson's theory have received experimental confirmation by both Peterson (17) and Kuo (14). The latter, by means of an ingenious arrangement of a maze, demonstrated that "many rats learned to select a correct path not only *not* because of recency or frequency, or both, but in spite of them." The maze employed by Kuo was so arranged that the rats could get to the food box by traversing either a long or a short route. Out of thirteen animals, all but two selected the short route finally. In totaling the number of entrances to these longer and shorter com-

[1] *Op. cit.*, p. 33.
[2] *Op. cit.*, p. 393.

partments, Kuo found that the shift from the longer to the shorter in many instances came about *suddenly* and with the advantage of frequency on the side of the longer path. If frequency and recency alone are responsible for selection and elimination in learning, such shifts ought to occur gradually and not suddenly.

It is not unlikely that, given a correct response, frequency will fix it, but frequency alone will not establish it in the first place. Neither will frequency plus recency explain this. The most vulnerable side of Watson's theory is thus its utter failure to account for the elimination of wrong responses. His theory is applicable only to the learning that ensues after the faulty, maladaptive, useless responses have been shunted off. Only if we view the learning problem as demanding that the animal go from the entrance to the goal can the factor of frequency be regarded as effective in determining the solution. But Watson does not refer to the frequency of this *total* series of responses, but to the frequency of any one *partial* response that is correct. In fact, as Peterson has suggested, frequency and recency would not explain the learning, but the learning would explain the frequency and recency. What is meant by this is that since learning is characterized by a *modification* of original behavior, we have not explained it until we have accounted for the modification. Frequency and recency account for what occurs *after* the modifications have been introduced, and hence leave the problem still the same old problem.

Carr's Intensity Theory. Before dismissing the frequency-recency theory, it might be well to call attention to the fact that Carr, while accepting these facts, has added another, that of *intensity,* in order to account for the *selection* of appropriate movements. We have already described what the factor of intensity is in terms of the law of association. Carr (3) applies this to maze learning by pointing out that movements along the true path become more vigorous or *intense* than those along blind alleys. The latter make for "hesitation, caution,

investigation, or disastrous sensory consequences. The true path presents fewer obstacles; it offers greater encouragement to freedom, continuity, rapidity, and vigor of motor expression. The difference is merely one of degree. The blinds check, thwart, and suppress activity more than does the true path, while the latter encourages and facilitates activity more than does a blind alley. The principle of relative intensity is here effective; acts are selected or eliminated according to whether the *sensory*[1] consequences tend to facilitate and intensify them on the one hand, or to disrupt and suppress them on the other." This view of the part played by the factor of intensity is excellently illustrated in terms of the drive concept as elaborated by Woodworth. The energy of the drive is like steam in a boiler. A cul-de-sac prevents this energy from finding an outlet. In fact, the thwarting of the drive intensifies the energy. It becomes dammed up. As a result, the accumulated energy makes for a much more intense reaction when the stimulus leading to the consummatory response is attained. Although such a view may not be adequate to render the mechanisms of elimination particularly intelligible, it does tend to shed light on the mechanism of fixation.

The Law of Effect. In his *Educational Psychology* (23), Thorndike explains the learning process in terms of three laws or principles. These are the *law of use*, the *law of disuse*, and the *law of effect*. The first two laws are intended to describe what takes place *after* a given response has been made to a specific part of the learning situation. According to the law of use, if such a response should be repeated the mechanism responsible for it would be strengthened; while according to the law of disuse, if no repetition takes place, it will be weakened. On the analogy of the physiology of muscles, these two laws are frequently combined into one, the *law of exercise*. Use or exercise a muscle and it becomes stronger; neglect it and it becomes weaker or atrophies. Thorndike simply extends this

[1] Italics ours.

conception to the sphere of mental reactions. But what determines whether the exercise shall take place or not and, consequently, whether a given act shall be retained or eliminated? The law of effect is intended to answer these questions. Briefly stated, the latter law says that the *consequences* of the act determine whether it will be repeated or not. In Thorndike's terminology, if the act is accompanied or followed by a satisfying state of affairs, it will be stamped-in or retained; if it is accompanied or followed by an annoying state of affairs, it will be stamped-out or eliminated. In brief, then, the law of effect states that learning is determined by rewards and punishments.

Although, from a common-sense point of view, it expresses one of the most obvious conditions under which learning takes place, the law of effect has not escaped criticism. Referring to the terms satisfying and annoying as employed by Thorndike, Cason (4) states that "*Satisfyingness and Annoyingness* are defined by Professor Thorndike as follows: 'By a satisfying state of affairs is meant roughly one which the animal does nothing to avoid, often doing such things as attain and preserve it. By an annoying state of affairs is meant roughly one which the animal avoids or changes.' A good many reactions of the organism would come under this category, but some of them would not be in the least 'satisfying,' as the term is used in popular speech. We are not at all aware of many of our physical activities. If Professor Thorndike means that the satisfying reaction is simply one which the animal makes, then the application of the law of effect would be a circular argument; for the animal would then be said to make the reaction because it is satisfying, and a satisfying reaction in turn would be said to be the one which the animal makes."

The question raised by the law of effect is that of determining how an after-effect of a response can influence a future response. For example, how does the rat's discovery of food at the completion of his first trial in the maze influence his

behavior during the second trial? There are, according to Thorndike, several possible explanations of such after-effects.[1] In the first place, the organism may "remember" a previous experience in a situation. This explanation ". . . would explain the learning of a cat who came to avoid the exit S at which it received a mild shock and to favor the exit F which led it to food, by the supposition that the tendency to approach and enter S calls to the cat's mind some image or idea or hallucination of the painful shock, whereas the tendency to approach and enter F calls to its mind some representation of the food, and that these representations respectively check and favor these tendencies." Thorndike objects to this explanation, however, partly on the ground that the alleged memories do not appear often enough during the learning (in the case of human learners). Another interpretation holds that ". . . when a certain connecting has been followed by a satisfier, the individual concerned repeats the connection or something more or less equivalent to it." We may call this the *rehearsal* theory. Thorndike disposes of this possibility, as it applies to animals, in the following way: "In the learning of chickens, rats, cats, dogs, raccoons, and the like, there seems small likelihood of any such inner repetition. A rat in a maze obtains freedom to run by turning to the right instead of the left at a certain point; and runs on. Does any competent student of rat psychology suppose that it thinks to itself as it runs *At such and such a place, turn right?* A cat in a black box pulls down a loop, and thereby escapes and obtains food. Why should it interrupt its enjoyment of the freedom and food by thinking some equivalent of *Shut up in black box, pull that thingumbob?*" A third possibility, which Thorndike discusses but does not wholly accept, states that "satisfying" connections last longer, in the mind or in the nervous system, than do "annoying" connections.

[1] The quotations in this discussion of the law of effect are from Thorndike's *Human Learning,* Lecture 4.

Thorndike summarizes his own theory of the law of effect as follows: "The connections formed between situation and response are represented by connections between neurones whereby the disturbance, or neural current, arising in one set of neurones is connected to another set across their synapses. The strength or weakness of a connection means the greater or less likelihood that the same current will be conducted from the former to the latter rather than to some other place. The strength or weakness of the connection is a condition of the synapse. What condition of the synapse it is remains a matter for hypothesis. Close connection might mean protoplasmic union, or proximity of the neurones in space, or a greater permeability of a membrane, or a lowered electrical resistance, or a favorable chemical condition of some other sort. Let us call this undefined condition which parallels the strength of a connection between situation and response the *intimacy* of the synapse. Then the modifiability or connection-changing of a neurone equals its power to alter the intimacy of its synapses."

In other words, a satisfying or an annoying experience modifies the synaptic connection in such a way as to account for the effect of an experience upon a subsequent experience. Thorndike does not attempt to describe what occurs at the synapse; the essence of his theory is the suggestion that the physiological basis of the law of effect is a synaptic phenomenon.

The Conditioned Response Theory of Learning. In Chapter II, attention was called to the popularity among psychologists of the conditioned response theory of integration and to the probability that conditioning and association by contiguity are similar if not identical concepts. Naturally, psychologists who find in conditioning an explanation of integrated behavior believe that this principle explains learning.

Smith and Guthrie (19) show how conditioning may account for learning, particularly with reference to the elimination of

incorrect responses. Their exposition of the matter is so lucid that it will bear repetition. They point out that "the situations the cat faces in the problem box are composed, for the most part, of visual stimuli that attract him, followed by stimuli to his proprioceptors and sense organs of touch that repel him, and these two classes of stimuli are given *by the same object*. He is instinctively attracted by the sight of the bars, but on reaching them, especially if they are rigid, he is instinctively impelled to turn away. This turning away is due to the resistance of the bars to his attempted manipulation and to his efforts to force his way between them. Approach and retreat are here original tendencies called forth by a single object.

"With repetition the sight of the bars becomes the conditioning stimulus for retreat, so that the conditioned response inhibits the original response. One by one the movements of approach to the various confining surfaces of the box are inhibited by the conditioned responses of retreating, until at last the animal is attracted by the door-opening device. The reason that this last movement is not inhibited is that that device itself never serves as the source of a stimulus that is instinctively avoided. Although the cat turns away from the button in response to the open door, he does so not because the button repels him but because the open door attracts him. Approaching the button and approaching the open door are the only approach responses that are uninhibited by conditioned avoidance responses, and while the door is closed the button alone calls forth an uninhibited response."

Let us attempt to apply the principle of conditioning to maze learning. In order to simplify the situation as much as possible, we may consider the rat's behavior in the "simple" T-maze, shown in Figure 22. To simplify the explanation further, let us assume that two trials suffice for the learning. In the animal's first trial, its choice of the right turn into C or the left turn into D is a matter of chance. By "chance" is

meant some unknown factor or group of factors. Assuming that it turns left and discovers its food, the rat will "remember" this correct turn in its second trial. In this second trial, however, it makes the turn at B before it can see or smell the food. (The experimenter has ruled out the possibility of its seeing or smelling the food at B.) According to the conditioned response hypothesis, the response, "turning left" has become conditioned upon such exteroceptive stimuli as affect the rat at B. These stimuli, therefore, are the equivalent of a sign that reads "Turn left." Now let us assume that the rat turns right in its first trial. In this event, it shows a negative or an avoiding response in its second trial: a negative response has been conditioned on the stimuli acting upon the animal at B. This resembles Smith and Guthrie's explanation of the animal's learning behavior in the problem box.

The Rôle of Kinesthesis in Maze Learning. But the foregoing explanation fails to tell us how the final sensory experience, at either D or C, affects the animal when it reaches B in the second trial. Going from B to D or from B to C is not a simple response unit; on the contrary, it involves running or walking a certain distance, say, of twenty-four inches. Either response, then, is really a series or a sequence of responses. Watson contends that the running or walking movements become conditioned upon the kinesthetic sensory impulses occasioned by the movements themselves. Turning right or turning left at B, as Watson explains maze learning, is not so much a response conditioned upon exteroceptive stimulation at B as it is a movement conditioned on the kinesthetic stimulation immediately preceding the movement. At any given instant during its running, the animal is receiving kinesthetic impulses which are its cues for its next movement. Thus its behavior is determined by a *temporal* kinesthetic pattern, consisting of a sequence of movements and their resulting sensory effects: movement *a* furnishes kinesthetic im-

pulses which result in movement *b;* movement *b* furnishes the impulses for movement *c,* and so on.

Macfarlane (15) shows by an ingenious experiment that this kinesthesis hypothesis, as it is called, does not fully explain the rat's learning behavior. In brief, he taught the rats to learn a maze under conditions comparable with Watson's, but he also forced them to *swim* through the same maze at intervals during the learning. He also took rats that had learned to swim the maze and required them to go through an ordinary maze of the same pattern. His point is that since the two methods of locomotion involved different kinds of movements, neither one, according to the kinesthesis hypothesis, should be transferable to the other. As he describes the difference, "The body of a swimming rat is extended, while that of the walking animal is, so to speak, gathered together; the muscles called upon to counteract the effects of gravity face new tasks." The results proved that transfer was effected easily: the facts were ". . . first, that the changes in kinesthesis brought about by the conditions in these experiments had but slight effect on the ability of the animals to traverse the maze without entrances into culs-de-sac, and, second, that such disturbances as there were, rapidly disappeared." Macfarlane concludes that while kinesthesis may determine *how* the rat travels through a maze, it does not explain where he will go.

The Alternation Problem and the Question of Temporal Patterns. Macfarlane admits the possibility that the animal's turning movements in the maze were conditioned upon its head movements. The rats were observed to cut corners, that is, to anticipate them by diagonal approaches, just as a man does in walking or driving around city streets. Since these head movements were similar in both the water maze and the ordinary maze, the learning might have been a kinesthetic process.

Some of Hunter's (8) results seem to refute this theory. They are quoted, in fact, by Macfarlane. In one experiment,

Hunter employed a maze in which the rat turned either to the right or to the left and then proceeded in clockwise or counter clockwise fashion, depending upon its choice, to traverse a simple rectangular path. Hunter's problem was to ascertain whether the animals could establish a temporal pattern of maze habits by forcing them to traverse the rectangles in certain fixed sequences. Stated differently, he tried to teach the rats to alternate their right and left turns in temporal order. But the animals were unable to learn such a sequence of turns as right-right-left-left-right-right-left-left (or, as the formula is written, *rrllrrll*). Hunter's rats demonstrated their ability to learn a very complicated *spatial* maze, or an ordinary maze with many culs-de-sac and many turns in the true path, but they could not learn a simple temporal maze. In another article, Hunter (9) summarizes his results, and comparable results obtained by other investigators, by stating that "the rat has shown his ability to master any complexity of bi-dimensional spatial maze. In the temporal maze he can master only with great difficulty, if at all, a combination as simple as *llrr*."

Types of Learning Theories. It appears that recent investigations point to the existence of factors in learning which were overlooked or insufficiently emphasized by the pioneer investigators. In point of fact, our discussion of theories of integration has prepared us to realize that the various theories of learning fall into classes. Some of these theories are frankly mechanistic in character, while others are less so. In a recent book, Tolman (25) attempts a more detailed classification of these theories. Among the theories which take exception to the interpretations advanced by Watson, Kuo, and other mechanistic psychologists, are those of the Gestalt and of the purposive psychologists. We shall consider these in the remaining part of this section.

Gestalt Psychology and the Learning Process. It will be recalled that the term Gestalt refers to the configuration or

pattern characteristic of a given experience. According to the Gestalt psychologists, learning should be explained on the basis of such configurations. They maintain that attempts to account for learning in terms of the integration of reflexes, the influence of specific stimuli, or sensations are futile; for, as they view it, the learning activity is a total experience, and not a fragmentary, partial experience. On the basis of this reasoning *they deny the validity of conclusions regarding animal learning and thinking unless the experimental conditions render it physically possible for the animal to grasp the total problem situation.* A problem box with the exit concealed from view by sawdust or with the door bolted from the outside cannot be expected to test the animal's possession of insight. Of necessity it must resort to trial and error manipulations. If the psychologist is interested in discovering the animal's ability to think or reason, he must arrange conditions which make it possible for the problem to be solved by such means.

The Gestalt psychologists further contend, as we explain elsewhere, that the conception of a response to a specific stimulus is an artificial abstraction not found in concrete experience. The response is always elicited by a configuration or a Gestalt. A Gestalt is more than the sum of its parts or its component stimuli: it possesses unique properties of its own that its separate parts do not possess, just as water possesses characteristics not found in either hydrogen or oxygen.

As applied to learning, this thesis is readily illustrated by a series of experiments performed by Köhler and summarized by Koffka (12). Köhler performed his experiments on chimpanzees and hens, and on a child not quite three years old. His problem was to determine whether such organisms react to specific stimuli, as opposed to stimulating situations or configurations. His method varied to suit the particular animal being tested, but the general plan was the same for all. We may briefly consider the experiment with the child to indicate the plan. Two boxes were presented to the youngster and he

was told to choose one. One of these boxes had a bright cover and the other a dark. The former contained candy, but the latter was empty. After 45 trials made over a period of two days, the child always chose the bright box and neglected the darker. The critical test was then made by substituting in place of the darker box one that was still brighter than the bright box; the child was thus forced to choose between the box for which it had presumably established a fixed habit of selection and another that was even brighter. In the words of Koffka, "the child invariably and without hesitation chose the new and the brighter box." Similar results were obtained by using gray papers in feeding the hens. The reaction was evoked not by an absolutely fixed, specific stimulus but by the relatively darker or lighter stimulus in the configuration.

The chimpanzee has served as a subject for much of Köhler's (13) work. Consistent with the Gestaltist's conviction that animals should be studied as they behave naturally, Köhler spent some time with a colony of chimpanzees on one of the Canary Islands. In one experiment, he put the ape in a cage which contained two bamboo rods so arranged that they could be fitted together to form one long rod or stick. The animal knew how to use one stick for the purpose of pulling bananas into its cage when the fruit was out of its arm's reach, but it had never joined two sticks together. On this occasion, Köhler placed the fruit too far from the cage to be reached by either stick. The animal tried to reach the food, using first one stick and then the other. After repeating this procedure a number of times, the ape pushed one stick out on the floor and then pushed it farther out with the other stick until it touched the desired fruit. All of the ape's immediate attempts were unsuccessful and it ceased trying. It then began to play with the sticks, apparently forgetting their possible connection with the food. During this period in its behavior, it accidentally joined the sticks together, and it eventually succeeded in using this new tool to secure its food. This experiment, as it is in-

terpreted by Köhler, demonstrates the rapid formation of a Gestalt: the two sticks became a tool for securing the food when they were joined to make one stick.

Many similar experiments are reported by Köhler, and by other Gestaltists. For example, if one end of a long rope is given to the chimpanzee and the other tied to the food, placed as usual beyond the animal's reach, the animal will perceive the relationship provided that all of the rope is visible. If, however, part of the rope is covered by straw, the ape may not see the relationship between the food and the rope, and consequently it may not pull in the rope to obtain the food. Again, when food is suspended from the ceiling of the experimental room, too high for the ape to reach by jumping from the floor, the ape may or may not use an available box as a platform. If the box is placed in one corner of the room, the animal may not form a Gestalt between it and the food. Indeed, it will waste its time in making futile leaps towards the suspended fruit. However, apes seem to differ from one another in intelligence. An ape has been known to pile one box upon another in order to erect a platform from which it can get its food.

Several considerations should be kept in mind in endeavoring to evaluate Gestalt psychology. In the first place, as numerous critics have pointed out, its claim to originality is unfounded, or at least exaggerated. Years ago, the American psychologist Huey proved that the reader of a printed page perceives words and phrases as units. Even before Huey's time, educators substituted the word method for the "A, B, C" method of teaching youngsters to read: they too realized that a word is not the mere sum of its letter units. Then, as Wyatt (34) contends, a Gestalt is not necessarily the sudden flash or inspiration that the Gestalt psychologists imply it to be. Because Gestalt psychology has tended to stress, by implication at least, the sudden appearance of a perfected insight, as indicated by the facial expressions of subjects who have the in-

sights, it has been called the "Aha!" psychology. Wyatt claims, however, that the insight comes typically as a series of "glimmering apprehensions." It is something that grows. Secondly, the insight may turn out to be a false hunch, or an illusion; hence, so Wyatt concludes, intelligence cannot reside in the insight *as such.* Finally, it should be realized that like any other explanation of the learning process, the Gestaltist's explanation represents one of several points of view. The behaviorist and the purposive psychologist have their respective concepts to account for the behavior of Köhler's apes.

Purpose in Learning. In so far as all behavior is purposive, learning is obviously purposive. In a sense, the term learning is misleading, for it is a synonym for behaving. Learning is adjusting and adjusting is a continuous process. Learning is indicated, even, when the sleeping man turns in his bed to assume a more comfortable position. Since he maintains this position for an appreciable length of time, he may be said to profit from his adjusting movement.

The kind of purposive behavior which we call learning behavior involves several factors. Tolman, Elliott, and others have described these factors as they can be inferred from the maze learning activity of the rat. Elliott (7) describes, in the first place, the knowledge factor. As he says, "The rat must 'know' the maze if he is to traverse it rapidly and with a minimum of errors." Notice that knowledge is defined objectively, with no implication that it presupposes a conscious idea or image. Reward is the second factor. It is the object or the situation that has a tension-relieving function. Elliott cites experimental evidence to prove that knowledge, in the absence of reward, does not produce *efficient* learning. Among other researches, he mentions Blodgett's (1) findings. This investigator first permitted his rats to explore the maze pathways without reward; he then placed food at the end of the path. The result was a sudden and marked improvement, showing

that the animals had been learning in the absence of reward. Knowledge and reward, therefore, are variable factors in maze learning. The third factor is the drive, or as we have termed it, the motive. We have repeatedly called attention to the fact that the non-motivated organism is an inactive or a lazy organism. It is therefore a non-adjusting or a non-learning organism. Tolman (26) adds to these a fourth factor, that of reward-value. Some foods, for example, are greater incentives to learning than are others. An analysis of this sort shows that purposive behavior implies the existence of factors which are ignored in the stimulus-response concept of behavior.

Concluding Observations. From the standpoint of this text, an adequate explanation of the learning process should take into account all of the points emphasized in the different theories of learning. It is not inconceivable, for example, that the rat utilizes kinesthetic cues in maze learning, but that he does so through some processes of Gestalt formation or of redintegration. Our conclusions in regard to theories of integration apply without reservation to theories of learning.

Quantitative Aspects of the Learning Process

There remain for consideration certain quantitative results obtained from studies in the psychology of learning. These are concerned not so much with the nature of the learning process as with the effects of learning upon behavior.

The Influence of Practice on Learning. The practice factor in learning has been subjected to extensive experimental attack. Laboratory evidence as well as everyday experience confirms the popular statement that "practice makes perfect."

This proverb is often taken to mean that practicing a given act makes that act perfect as the learning of it progresses; but as a description of what takes place such an interpretation is faulty. Consider the familiar case of a child learning to write. In the beginning it indulges in a multitude of superfluous movements. It twists its legs around the chair,

squirms about, wrinkles its forehead, grasps the pencil with excessive force and with the whole hand; in short, its whole body is active. With continued practice these unnecessary, extraneous movements are eliminated and the writing movements more limited to those essential to that act. In other words, the practice did not improve the act that took place at the beginning, but brought a different act into being. In the same way, the service of a novice at tennis becomes a different act when the novice becomes a champion. Only in terms of attaining the objective of learning does practice tend to make perfect.

The Physiological Limit of Learning. Actually, nobody ever achieves perfection in any absolute sense of the word. As far as motor performances are concerned, the most that we can hope to do is to attain our physiological limit for the given performance. Such attainment represents the nearest we can come to perfection. By physiological limit is meant the utmost that our bodily equipment will enable us to do. A track coach, for example, can teach a sprinter to negotiate the hundred yard dash in a style which, as far as form is concerned, is that of the world's champion sprinters. But despite the fact that he can teach them the requisite style, he cannot make all of the track candidates ten-second men. It may be that a given candidate on his first attempt sprints the distance in 14 seconds. As a result of practice and following the coach's suggestions, he eventually cuts his best time down to 12 seconds. Then, despite the utmost diligence and effort, he fails to better his 12-second performance. His physiological limit for the hundred yard dash would be 12 seconds. For human beings in general, the limit is a fraction less than 10 seconds. In all seriousness we might ask why it is that nobody has ever succeeded in lowering the record to 8 seconds, or even less than that. The answer, of course, is that a definite minimum time must elapse for the bodily machinery involved to function. Nothing takes place in no time. In the case of run-

ning, a certain amount of time must be allowed for the transmission, to the brain mechanism for hearing, of the afferent impulse set up by the starter's pistol. An additional amount is consumed in the passage of the neural disturbance from the latter mechanism to the muscles used in sprinting. Even after the efferent impulse reaches the muscle, a measurable interval elapses before the muscle responds to that impulse.

The time required for the functioning of the physiological mechanisms operative in a given activity thus sets a limit to the speed with which that activity can be executed. It is this limit which is referred to by the term physiological limit. It will differ for different persons, but to the extent that they succeed in performing the given activity in the minimum time that their particular physiological equipment permits, they may be said to have reached perfection so far as speed of performance is concerned. In this *relative* sense the performance of our trained 12-second sprinter is as "perfect" as that of a 10-second man, despite the absolute difference of 2 seconds in their records.

The physiological limit for any given activity can be approximately determined only by experimentation. One of the important psychological questions connected with such experimentation has to do with the rate of improvement by means of which this limit is approached. Assuming that it required ten weeks of training, one trial per week, for the sprinter to reduce his time from 14 to 12 seconds, did this reduction come at a uniform rate of $\frac{1}{5}$ of a second per trial, or did some other irregular type of rate characterize the learning? It may be stated quite dogmatically that so far as existing experiments are considered, the improvement is never of a constant, uniform character from the beginning of the learning until the physiological limit for that activity is reached.

Zero Preparation. One difficulty involved in the study of this question is that of deciding when the learning *begins*. This is known as the problem of *zero preparation*. A subject

may have had no previous experience with the precise activity he is setting out to learn, but to the extent that he is capable of going through the elementary movements required in the initial stages of the learning, he is not starting from "scratch." For example, Thurstone (24) reports that in learning to typewrite, a subject who has never touched a typewriter before may succeed in writing as many as 27 words in four minutes. In the same way it may be demonstrated that the student just beginning piano lessons does not start from zero ability. In the very first lesson he succeeds not only in striking the keys, but also to some extent in striking the correct ones. The best that psychologists can do under the circumstances is to start their experimental work as far back in the learned performance as circumstances will permit and to regard this start as a sort of arbitrary zero.

Learning Curves. In the endeavor to get a picture of the influence of practice on the rate of improvement, the customary method is to draw a practice curve. It is obvious that the curves of learning presented on the previous pages are also practice curves inasmuch as they give a graphic picture of the improvement wrought in an activity by repetition. Whether a given curve is to be called a learning curve or a practice curve is largely a matter of emphasis since it depends on the particular purpose for which the experiment was undertaken. As indicated on the accompanying practice curves, it is customary to use the abscissa or x-axis to represent the lapse of time and the ordinate or y-axis to represent the improvement as measured by increase of speed or increase of amount of work done. Sometimes it represents a decrease of the number of errors, or possibly a decrease in the time required to complete a unit of work.

Inspection of the learning curves shown in Figures 23, 24, and 28 shows that their general tendency is to approximate the type of curve represented in Figure 25, the so-called "typical" learning curve. The student of physics will recognize

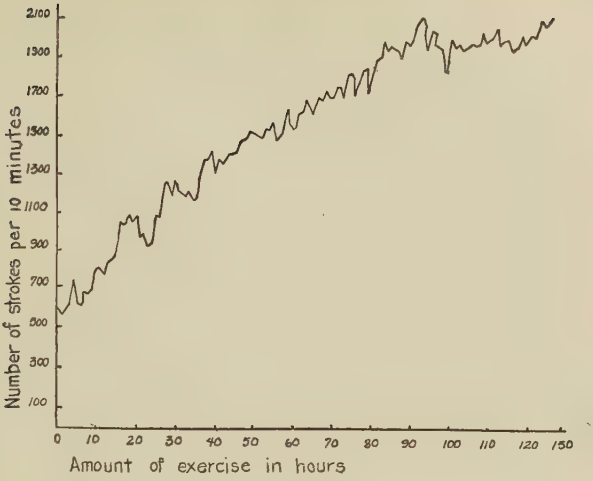

FIG. 23.—Learning curve showing influence of practice in learning to typewrite by the touch method in the case of one individual. (From Book, W. F., *The Psychology of Skill.* Gregg Publishing Company, New York, 1925.)

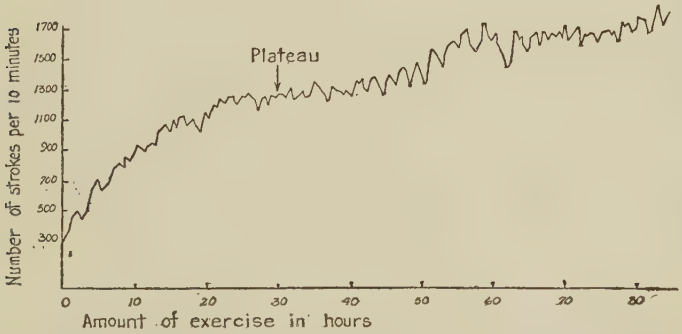

FIG. 24.—Learning curve showing influence of practice in learning to typewrite by the sight method in the case of one individual. (After Book.)

this curve as one that shows *negative acceleration.* The term means that as the learning continues, less and less is accomplished in each succeeding practice period compared with the previous one. If the distance per unit of time traversed by a

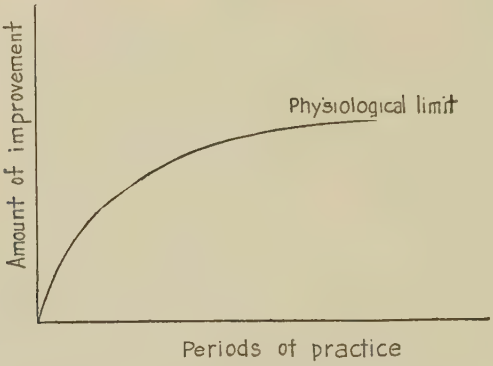

FIG. 25.—The so-called typical learning curve.

As explained in the text, this curve is often regarded as typical of learning. Reference to Figs. 23, 24 and 28 will show that they tend to approximate a curve of this shape. It may be doubted, however, whether one is justified in regarding any particular kind of curve as *typical* of learning. The kind of curve obtained in learning experiments varies with the measure of progress employed, the number and duration of the practice periods, the physical condition of the subjects, and a number of other factors. Even if it is assumed that a curve such as this one is approximately typical, it deviates from actual, as opposed to theoretical, curves in two respects: (1) it starts from zero (zero preparation) and (2) it is too smooth or continuous. Actual learning curves are characterized by many fluctuations. At best, this curve typifies a theoretical ideal.

long outfield fly were measured and plotted we would get a curve showing negative acceleration. In other words, the speed of the ball grows less as it recedes from the home-plate; that is, the ball covers less distance each succeeding interval of time. Such a learning curve indicates that improvement is relatively more rapid in the beginning than in the later stages

of practice. It will be noted that the final stretch of the curve tends to be parallel with the base line. This final stretch is the graphic indication of the physiological limit. It represents *zero acceleration.*

It will be noticed that actually none of the curves is perfectly smooth. Such deviations from an ideal form are due in part to factors other than practice. Subjects vary from day to day in interest, incentive, fatigue, and physiological condition. Even weather conditions and the nature of the room temperature tend to influence human performances. Disappointment and elation have been known to influence learning experiments, just as they have been known to interfere with school examinations. With such a multitude of uncontrolled factors playing a part in the experiment, it is not astonishing that the curves show so many fluctuations and deviations from a theoretically "smooth" form.

The Plateau. Considerable controversy has arisen concerning one aspect of these fluctuations. Reference to Figure 24, the practice curve of typewriting by the sight method, will show a level portion in the middle of the curve. A level of this kind is called a *plateau.* It is interpolated behind the initial spurt in the acquisition of ability and a second increase of achievement. Since plateaus are generally absent in curves of animal learning, they are regarded by some psychologists as uniquely characteristic of human learning. Other psychologists regard them as artifacts, produced artificially by crude measurements of learning. Apparently the plateau indicates that for a relatively prolonged period the learner is not profiting by his experience. In other words, his improvement is at a standstill. In the opinion of some psychologists, the plateau represents actual improvement of a kind which is not indicated by the objective results. Evidence for this view is found in the spurt of improvement which follows the plateau. All psychologists agree that plateaus do not universally characterize human learning curves.

The Curve of Forgetting. In addition to the curves so far described, psychologists have often plotted *curves of forgetting*. Such curves give graphic pictures of the speed with which we forget material once committed to memory. The technique used in such experimentation varies, depending on the kind of material that is memorized. In general, it calls for learning the material to a definite standard of efficiency and noting how much of it is retained after the lapse of a stated time interval. As in other kinds of memory work, the subject is often required to memorize *nonsense syllables*. By this is meant a syllable made by combining a vowel and two consonants into a meaningless combination of letters, such as ZIK, POG, RAJ, NUR. The consonants always flank the vowel. This material is superior to common words, prose, or poetry because it enables the experimenter to control the factor of familiarity.

Ebbinghaus (6), who introduced the nonsense-syllable technique into experimental psychology, studied the question of the rate of forgetting by this means. One of his curves is shown in Figure 26. It will be noted that forgetting is very rapid immediately after the learning and becomes less and less rapid as time goes on. Such a curve indicates negative acceleration. A similar curve is shown in Figure 27. This curve, as indicated by its accompanying description, shows the amount of lecture material retained by students after varying intervals of time. In this study, students of elementary psychology were tested to find out how much of a college lecture is retained. Jones (10), who conducted the investigation, reports among other results that at the close of an ordinary 40-minute college lecture, students retain on the average but 62% of the contents of the lecture. As he states it, "only about ⅔ of a lecture 'gets across.'" After 3-4 days but 45% is retained and at the end of 8 weeks only 24% of the lecture can be recalled. These results, it should be said, apply to *new* and insufficiently learned material.

Individual Differences and Practice. Another unsettled problem is concerned with the influence of practice on the variability of individuals. Does practicing a given act make

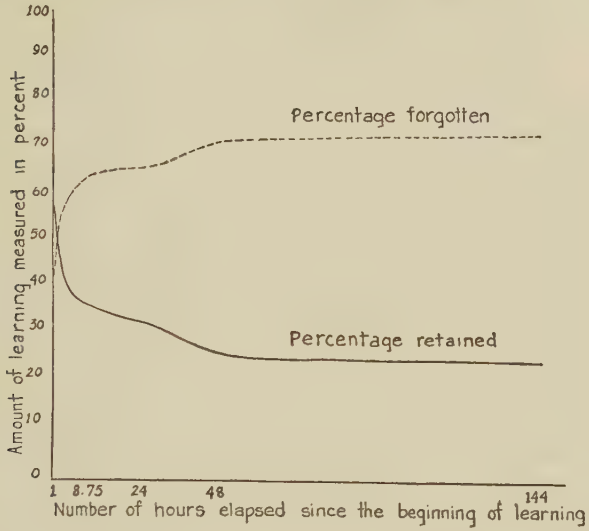

FIG. 26.—Curves showing the rate of forgetting a series of nonsense syllables learned to the point of one correct reproduction.

The solid curve indicates the percentage of time saved in re-learning the lists of nonsense syllables after they had been forgotten. The broken curve shows the percentage forgotten after the lapse of varying intervals of time. Curiously enough, the former curve is usually designated as a *curve of forgetting*. Actually it is a *curve of retention*. Compare the broken curve with the curves of learning shown in the preceding figures.

individuals more alike, less alike, or the same with respect to that act? Consider the following example:

Ten boys of the same age with no previous training in pole vaulting are given systematic practice in that performance. Before the practice, which extends over a period of years, their relative abilities are measured. At that time X is best,

Y is poorest, A is fifth, and the others rank in between. Now while it is agreed that practice will improve the performance of each one, the question is whether the improvement will be the same in amount for all of them. At the end of two years of practice will X still be first, Y last, and A fifth? Or will Y

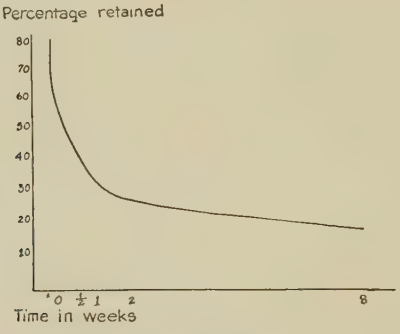

Fig. 27.—Curve of forgetting for content of a college lecture. (From Jones.)

This curve illustrates graphically the speed with which the material presented in a college lecture, 40 minutes long, is forgotten. Although the amount retained at the end of the lecture is given as 80%, the actual average per cent obtained was 62%. The former figure represents a statistical correction introduced into the data to allow for the fact that the memory test given at the end of the first lecture, designed to measure immediate recall, as opposed to delayed recall, does not perform this function in an absolute sense of the word *immediate*. As Jones puts it: "From what we know of the curve of forgetting for just learned material, it is probable that the content of a lecture is forgotten more rapidly during the lecture itself than at any time afterward. This implies that our forgetting graph, as shown above, should not begin at 62%, the mean for the first test, but at some higher point, just how much higher we cannot say. If every item presented and discussed is at some time . . . apprehended by every member of the class, the curve would begin at 100%. But this ideal is probably never realized in any classroom, and for convenience we have designated the starting point of the curve at the midpoint between 62 and 100, which is at least as probable a position as any other."

be first and X last and the others similarly finish in inverse order? In technical language, how does practice affect the relative and absolute variability of individuals?

As has already been stated, no absolutely certain answer can be given to this problem. Kincaid (11), however, has gone over twenty-four publications dealing with a diversity of performances, including mental multiplication, addition, reading, ball tossing, javelin throwing and so forth, and has treated the results obtained by refined statistical methods. The results of her study show that the level of ability manifested in the early stages of practice is prognostic of later relative ability. The brunt of the evidence also indicates that "differences generally decrease with practice." According to these statements, the relative standing of individuals tends to remain approximately the same, while the amounts by which they excel one another tend to become less.

Spaced *versus* Unspaced Learning. Among the important problems of learning is the determination of the most efficient way to distribute practice periods. Is it more economical of time and energy to concentrate our learning into a single long practice session, or should the practice be spread out over a period of days, weeks, or months? If we have 100 new French words to learn, or if we want to learn to ride a bicycle, or drive an automobile, shall we keep practicing these tasks at one sitting until we master them or become exhausted, or shall we put in half an hour a day for a sufficient number of days until success is attained? The question is which method, that of concentrated or *unspaced* practice, or of distributed or *spaced* practice, will make for greater retentiveness and less energy expenditure?

It is obvious that where the act to be perfected calls for actual changes in the bodily tissues, the practice must be spaced. The benefits to be derived from the "daily dozen" will not accrue if the exercise is postponed until every twelfth day and then one concentrated "gross" substituted for the

days that were skipped. If in the course of spring practice a batsman finds he must hit about a thousand balls before his "batting eye" returns, clearly he will not achieve the same end by devoting a single day to an orgy of batting. While the superiority of spaced practice is thus obvious when extreme cases are selected, its superiority is neither obvious nor to be taken for granted in less extreme cases.

Even in extreme cases the question of the exact amount of practice to be indulged in at any one practice period cannot be settled out of hand. Neither can the related question of the optimum interval between one practice period and the next be decided by guesswork. From one point of view, even experimentation cannot settle such matters in any *absolute* way. The number of combinations and permutations for any single activity is infinite. Let us assume that the activity to be mastered is that of memorizing fifty lines of poetry requiring five minutes for one reading. What is the best way of accomplishing the task? Consider some of the possibilities. The poem may be read once a day for as many days as are necessary to memorize it. It may be read 12 times in one hour, then an interval of an hour may be permitted to elapse, followed by another hour of study and so on. Or else the interval may be reduced to half an hour or ten minutes or two days. Or shall the poem be read three times every third hour? As far as such infinite possibilities are concerned, no one method is to be regarded as the most efficient, except in the *relative* sense that of all the combinations that have been tested with the given kind of material, one is demonstrated to be superior to the others.

The following simple experiment, performed by Starch and quoted by Strong (20), may be considered in this connection. Four groups of people were drilled for 120 minutes in a substitution test in which digits were used to replace letters. The mental processes involved are comparable to code writing. While the total time expended by each group was the same, the

distribution of the time differed for each group. Group number one spent two 10-minute periods per day for six days on the task; group number two worked 20 minutes at a time each day for six successive days; group number three put in one 40-minute period every other day for three days, while group num-

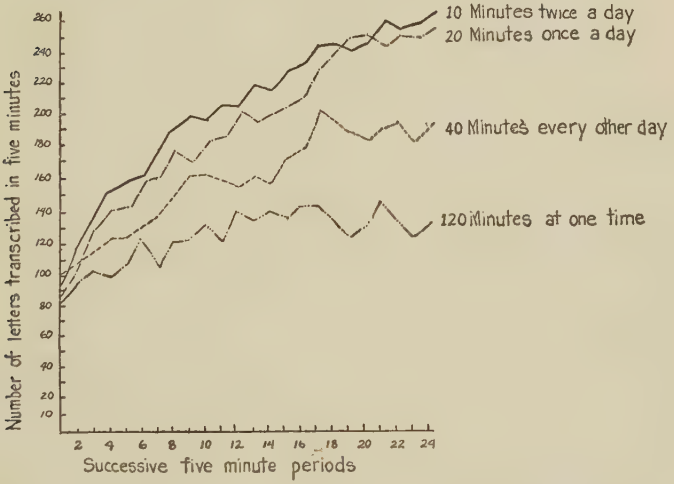
10 Minutes twice a day
20 Minutes once a day
40 Minutes every other day
120 Minutes at one time
Number of letters transcribed in five minutes
Successive five minute periods

FIG. 28.—Curves showing influence of spaced *versus* unspaced learning in a substitution test. (After Starch, D., *Educational Psychology*, 1920.)

ber four concentrated the work into a single 120-minute period. The results are indicated in Figure 28. It will be noticed that the first group accomplished the most, with group number two a close second, the 40-minute group third, and the fourth group last. The first two groups achieved very much more than the last two, practically twice as much, and this despite the fact that they devoted no more actual time to the learning. However, as far as extent of time intervening between the beginning and the end of learning is concerned, the six-day interval tells in favor of the concentrated group, assuming that by

devoting about 300 minutes to the work they could have equaled the performance of the first group. In general, it may be said that spaced study is superior to unspaced as far as time spent in work is concerned, while unspaced is superior as far as extent of time is concerned.

Part Learning and Whole Learning. Closely related to the problem of spaced and unspaced learning is the problem of the relative advantages of learning a thing part by part, or sectionally, as opposed to learning it as a whole. This is usually referred to as the problem of part *versus* whole learning. To illustrate by a few concrete cases, is it more efficient in learning a poem by heart to memorize it stanza by stanza than to read it over from beginning to end until it is mastered? In learning to play golf should one first practice gripping the driver, then devote one's attention to the correct stance, follow that with practicing the swing, and then complete the learning by practicing the whole act of teeing off? Or should the act as a whole be practiced from the start? Should the swimming instructor have his pupils first practice the leg movements until those are perfected, then the arm movements until they are correctly executed, and finally have them practice the simultaneous combination, or would his teaching be more effective if he required the pupils to practice the arm and leg movements together right from the start of the learning? There is some question as to what constitutes a "part" and what constitutes a "whole." Then, the specific end to be accomplished by the learning should be taken into consideration. In general, however, all evidences point to the superiority of the whole method.

Transfer of Training. The necessity for caution and careful experimentation is also clear in the case of another learning problem that has been somewhat more successfully coped with than the part-whole problem. This is usually referred to as the question of *transfer of training*. It is the problem of determining to what extent learning one thing carries over to

more or less related performances. Does learning to drive an automobile of a given make help or hinder (and to what degree) when we try to learn to drive one of a different make? Will a child who is trained to be neat in his dress carry over this particular habit of neatness to his penmanship, his note-taking, or his care of animal pets? Does training in algebraic reasoning improve one's ability to reason out legal, ethical, and literary problems? Does training our memory for telephone numbers automatically improve our memory for names, dates, faces, titles of books, daily appointments, and chemical formulæ? Students of pedagogy will recognize this as the familiar educational problem of *formal discipline*. The rigid supporter of formal discipline is in reality an adherent of the antiquated faculty psychology. Like the phrenologist, he conceives of the mind as being made up of fixed forms or faculties. Accordingly, if one of these "faculties" like that of memory is trained or disciplined with one kind of exercise such as memorizing poems, then the beneficial results of this training will be evident in the markedly improved retention of everything else. Since the study of grammar calls for the analysis of sentences, the discipline it gives the "analytic faculty" will fortify the student's ability to analyze business problems, chemical compounds, murder mysteries—in short, any affair that involves analysis.

While no psychologist to-day lends credence to this extreme application of the principle of transfer of training, it is unfortunately true that many educated, non-psychologically trained individuals do. Concrete laboratory experiments have shown that the amount of transfer is not only limited, but that often it is either completely absent or even negatively present. As Webb (32) has pointed out, we may have *positive* transfer when learning in one situation aids in a subsequent situation and *negative* transfer if the former hinders the latter. When the first learning exerts no effect on the second we may speak of *absence* of transfer. It is also well to recognize that the

acquisition of new material may influence the retention of old material. A baseball player who takes up football may find, upon resuming the former game, that his football experience aids, hinders, or has no effect upon his baseball playing. The term *retroaction* is used to refer to the possible influence of a new act on an old, established act. Theoretically, there are also three retroactive possibilities: positive, negative, and absence of retroaction. If mastery of a new situation strengthens the retention of an old habit, we have *positive* retroaction. In terms of our example, if the ball-player is helped by his football training, it is a case of positive retroaction. Should there be an actual loss in his baseball proficiency due to his playing football, the process would be called *negative* retroaction, or *retroactive inhibition.* Finally, if the new habits exercise no influence on the old, we speak of *absence* of retroaction.[1]

Owing to the relatively small amount of transfer revealed in many experimental investigations, a misinterpretation to the effect that there is absolutely no transfer of training has been introduced into semi-popular debates on the formal discipline question. Such an assertion is as unwarranted as that of the extreme adherent of formal discipline who maintains that there is a tremendous amount of transfer. It is all a question of degree. Coover (5) has studied this question very intensively and critically. In the course of this study he presents a summary of 18 investigations covering a wide diversity of mental functions.[2] In all of these there was *some* improvement carried over.

According to prevalent interpretations of such improvement, however, it is not due to the training of any general mental "powers" or "faculties," but rather to the training of specific functions or attitudes that are common to the two performances. In this sense an individual who has found that his

[1] *Op. cit.,* pp. 1-2.
[2] *Op. cit.,* pp. 31-32.

memory for names is improved if he writes the names down soon after hearing them, may be able to transfer this mnemonic device to other memory material such as dates and titles of books. To the extent that such increased success in remembering names gives him confidence in his "memory," the general attitude of confidence may be transferred to other memory situations. A person who has difficulty in perfecting his technique of piano playing because of inability to control the movements of the fingers of the left hand may find that after practicing typewriting for several months his piano work has improved. This would be a transfer of the specific movements of the fingers in the direction of increased control due in part to mere strengthening of the muscle groups involved. To argue from such a finding that the would-be pianist should practice typewriting would be absurd. Yet such an argument is no more absurd than that of the pedagogue who asserts that all would-be lawyers should study chemistry or mathematics, because such subjects call for close reasoning and the good lawyer must be able to reason closely.

The practical implications of experimental studies of transfer of training should be fairly clear; namely, that training should always be of the process or processes that the individual intends to use. If an individual desires to become competent as a pianist or lawyer, he ought to occupy his time with piano practice or legal problems. If he wants to be a chemist he requires training in chemical reasoning and not legal reasoning. That is to say, it would be inefficient for him to study law solely because such study would *in part* train mental functions brought into play by chemistry when those same functions would be exercised directly in the course of his chemical studies. On the other hand, we must not overlook the fact that since there is *some* transfer of training from one activity to the next, we may be profiting more than we realize from much of our activity. The exact nature of this transfer can only be

determined by actual experiment, for what superficially appear to be identical functions may really be antagonistic. Actual measurement of presumed transfer effects should replace *a priori* guesswork.

It is also well to remember, as Thorndike (23) has pointed out, that "a very small spread of training may be of very great educational value if it extends over a wide enough field. If a hundred hours of training in being scientific about chemistry produced only one hundredth as much improvement in being scientific about all sorts of facts, it would yet be a very remunerative educational force. If a gain of fifty per cent in justice toward classmates in school affairs increased the general equitableness of a boy's behavior only one-tenth of one per cent, this disciplinary effect would still perhaps be worth more than the specific habits." [1]

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[1] *Op. cit.,* p. 282.

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CHAPTER VI

LANGUAGE, INTELLIGENCE, AND PERSONALITY

Ordinarily the words *thought* and *thinking* are employed in a wide variety of senses. Dewey (7) has pointed out that any kind of reaction from an idle fancy to a piece of complicated reasoning is indiscriminately labeled "thinking" in our daily speech. We find people saying that they "think it must be time for lunch" or that they "think the maid is dishonest." Sometimes they "think heredity is more important than environment," just as they "think the price of coal is exorbitant," or that the doctor "thinks the patient's illness might be pneumonia." If we were to collect a representative assortment of examples in which the term *thinking* occurs, we should find that it can be divided with approximate accuracy into the following four classes:

(1) Mere opinions of a simple descriptive nature expressed in a casual, unreflective, effortless manner. Examples of this group are to be found in such statements as "I think golf is a wonderful game," "I think it is bedtime," or "I think I'll wear my new shoes to-day." The word *believe* is often substituted for *think* when employed in this sense.

(2) Any consideration of events or things not present in concrete reality. In this sense of the term we can *think* of last month's issue of a magazine, of our next birthday, of our departed friends, of the sound of a violin, of the arrangement of the rooms in our childhood home, or of what we are going to have for lunch to-morrow. Our playful fancies and day-dreams represent thinking of this sort. Synonyms for this usage of the word are *imagine* or *picture*.

(3) Cases that involve an element of doubt or uncertainty

as illustrated by such expressions as "I think it must have been close to 9 o'clock when he arrived" or "I think I may become a lawyer." Thinking of this sort demands a certain amount of reflection. To a limited extent the pros and cons bound up with the issue under consideration are hastily reviewed. In this type of usage we find the word *think* synonymous with *judge, estimate,* or *consider.*

(4) Thinking of the problem-solving type. A convict planning his escape, a physician trying to diagnose a puzzling illness, an engineer designing a new kind of engine, or a business man deciding on momentous investments—all are indulging in this type of thinking. It is also described by such verbs as *ponder, cogitate, reflect,* and *reason.*

Of course such a four-fold classification has no hard and fast lines of distinction. It is easy to find examples that belong partly in one class and partly in another; but for purposes of convenient reference this classification may prove helpful. It certainly emphasizes the variety of meanings attached to the term *thinking.* For some of these varieties we have special names depending on the dominant characteristic of the particular case of thinking. If the thinking is concerned with an object immediately perceived, the thinking is said to be *perceptual.* An automobile mechanic trying to think of the reason for a peculiar sound he is listening to as the engine is running is indulging in perceptual thinking. Another example is that of a chemist who, while looking at a particular solution, remarks, "I think this acid is not chemically pure."

Often thinking is predominantly occupied with objects or events that are not present to sense. Such thinking is described as *imaginative.* A novelist is thinking imaginatively when, in the privacy of his study, he constructs the plot and decides on the characters of his next story. In case he thinks of including some event of his school days just as he experienced it, the event is said to be *reproductively* imagined. Thinking of it is a matter of *memory.* If he modifies the event to fit the plot

of the story more dramatically, the event will then be *productively* or *creatively* imagined. In the latter instance, he reconstructs the details of the event to suit his plans. However, both in reproductive and productive imagining the experience of the individual is utilized. All elements of imagination are rooted in experience. For this reason, we cannot even in imagination conceive of the taste of magnetism or the sound of light. What we can do is to rearrange the items of our experience into a pattern or *construct* which we have never experienced. In this way, we can imagine a herd of sheep reading Latin, or a world composed exclusively of altruistic people.

Frequently esthetic attitudes represent the focus of thinking, as when we admire the beauty of a landscape or the majesty of a tree. As in other cases of thinking presently to be discussed, the striped musculature is often noticeably involved in *esthetic* thinking. For example, in gazing at the Leaning Tower of Pisa the observer may involuntarily set his body at an angle opposite to that of the tower. His esthetic judgment regarding the poor balance of the tower may be a projection of his own unstable equilibrium. The technical name for this tendency to "feel oneself into a situation" is *empathy*. Empathic reactions are responsible for many esthetic opinions. A familiar instance of this kind of thinking is found in our dislike of a small, light picture suspended from the molding by a thick, heavy cord.

There are still other kinds of thinking that might be listed, but those enumerated serve to show their extreme variety. Actually, of course, thinking as such differs not in *kind*, but in its *product*. Whether a given specimen of thinking is to be described as perceptual, abstract, reasoned, imagined, creative or stereotyped depends on the result of the thought.

Language and Thought

It is frequently asserted that we think in words. This is obviously not true if the term thinking is taken to include the

perceptual process: we may recognize objects and individuals the moment we perceive them. Similarly, ideas apparently occur to us before we express them in words: we first get "flashes" or "insights" and then proceed to elaborate them verbally. Nevertheless, taken by and large, language and thinking are almost inseparable. Titchener (34) summarizes this excellently in these sentences: "It has often been said that thought would be impossible without words; and it is true that we can hardly conceive of human thought save as formed and embodied and expressed in language. Thought and articulate speech grew up, so to say, side by side; each implies the other; they are two sides of the same phase of mental development." [1] Whether all language is to be classified as thinking is another matter.

The Development and Function of Language. In order to understand the relationships which exist between language and thought, it is essential to consider both from the functional or purposive standpoint. In general, all thinking is purposive, for it is concerned with the business of living. Mental development involves thinking, and mental development is almost synonymous with intelligence. Significantly, the latter is defined by many psychologists, possibly by the majority of them, as the mental capacity to make adjustments to novel situations. When a man "thinks his way out of a situation," he is making mental adjustments.

F. H. Allport's (1) analysis of language development in the child interests the psychologist because it stresses the functional and the social aspects of linguistic behavior. As regards the infant, Allport finds the beginnings of language not in vocalization but rather in gesture. To use his illustration, the infant refuses any unwelcome substance that touches its lips by turning its head and thus avoiding the unpleasant contact. This is one form of a simple avoidance reflex or reaction, and as such it is executed without deliberation and

[1] *Op. cit.*, p. 267.

without conscious anticipation of results on the part of the infant. The response ". . . serves as a sign which is readily understood and reacted to by the person offering the rejected substance." By a process of conditioning, according to Allport, the infant learns to employ this movement as a sign or a signal. In other words, it uses the movement as a gesture by which it controls the behavior of others. Incidentally, William James observed, nearly half a century ago, that the horizontal head movement used by the human adult to express negation developed from this avoidance reaction of the infant; but it remained for Allport to point out the social significance of the response.

Allport describes a pre-linguistic stage in the child's growth, during which it utters sounds primarily because it is equipped with a vocal apparatus. It makes vocal sounds for the same general reason that causes a dog to bark or a snake to hiss. And for explicable reasons, its different vocalizations are expressions or indications of certain emotional states. Sobbing, for example, is part of a physiological disturbance which involves chiefly the respiratory mechanism; it differs from the scream of pain which obviously indicates another kind of disturbance. When any particular vocalization is responded to by the nurse or mother in such a way as to relieve a tissue need, it easily becomes a signal or a call for relief. Thus, the anger cry, if used successfully, soon becomes what Allport calls an "infantile imperative."

Allport further describes three stages in the ontogenetic acquisition of language. During the first and second of these stages, the child makes a variety of random articulations which tend to become habitual through the principle of the fixation of circular responses. Thus, the child says "da." In uttering this syllable, it stimulates its own auditory mechanism. Allport assumes that the afferent neural impulses originating in the ear become converted into motor impulses which go to the vocal apparatus. Then, since the vocal mechanism is set for

articulating "da," the auditory stimulus becomes a conditioned stimulus for the articulation of the syllable. On a subsequent occasion, therefore, the child tends to say "da" when it hears the syllable spoken by its mother. For that matter, a phonographic reproduction of the sound likewise would serve as the conditioned stimulus. The child does not "imitate" the sounds made by its mother; indeed, the reverse is true. In her enthusiasm over the discovery that her child is learning to talk, the mother repeats the sounds made by it and thus provides the conditioned stimuli which prompt it to utter the appropriate sound.

In the final stage of language acquisition, the child's responses become conditioned upon objects and situations. As Allport describes this stage, the child's articulation, "da," becomes conditioned not only upon the sound, "da," but upon the object, *doll*. In order to explain this development we need only presume, as we well may, that the typical English-speaking mother regards her child's "da" as an attempt to say "doll"; hence she gets the object and holds it up before the child. As a result, "a conditioned response is thus formed; the afferent visual impulse from the doll discharges its energy through the motor pathways of the speech pattern of pronouncing the word. The object itself thus becomes a stimulus adequate for evoking the response of speaking its name."

Just as the infant uses its screams and anger cries as means toward ends, so the child according to Allport ". . . learns to use his naming habits as *demanding* habits. He learns, in general, that words are instruments by which he can control the behavior of others with reference to his own desires."[1]

A General View of the Function of Language. Allport stresses the fact that the child *uses*, rather than merely speaks, the verbal expressions which it has learned to articulate. It is not engaged in the task of memorizing lists of words; on the contrary, it "wants" this and it "wants" that, and it finds that

[1] *Op. cit.*, Chapter VIII.

"give me," "take away," and similar verbalizations are extremely serviceable in its attempts to satisfy its desires.

Language has this identical function in adult behavior. A man becomes conscious of this fact when he visits a foreign country without first learning something of its language. He may study a manual of "conversational" French, for example, so that during his sojourn in Paris he can order his meals, make purchases, and find his way about. Likely as not, he will discover himself at times in the position of a child; that is, he will necessarily resort to gestures and pantomime, and to child-like attempts at pronouncing difficult words. His linguistic attempts literally will be the equivalent of "baby-talk."

The thinking process as described by Watson (37) takes place largely in terms of words. To use his illustration, a man learning to play golf learns also to talk golf: "Furthermore, since so many millions of man's adjustments are verbal, the verbal organization soon comes to be dominant. The verbal processes soon come to initiate and control all of the arm, leg and trunk organization. Watch the golfer as he makes a bad shot; ask him what he did wrong. If you are a lip reader you can in many cases read his words without asking him any questions. 'I stood too close to the ball. I've got to learn to stand back. I bent my legs; I didn't follow through.' Watch him address the ball for his next shot. He says to himself, 'Stand a little back,' and he steps back, etc. The verbal organization, in addition to its usefulness in getting notice in the club house, is on the field an intimate part of the total organization called into action when playing golf."

Our interest in Watson's description centers upon the fact that, notwithstanding his anti-purposive views, he assigns a definite function to linguistic mechanisms. The golfer's verbalizations constitute a set of directions; if necessary, a forgetful golfer could write similar instructions in his memorandum book, just as he might write the directions for going to a golf course in a new locality.

It has been recognized for years that a human being uses language to control the behavior of other human beings. Textbooks of business psychology state the essential qualifications of a good "sales talk": it must appeal to the interests of the prospective customer; it must not offend him; it must utilize the principle of direct, as opposed to indirect, suggestion, etc. In short, it is a series of verbal stimuli designed for the purpose of controlling human behavior. Consider also the verbal devices used in the everyday control of behavior. It is obvious, for example, that "flattering remarks," "endearing speeches," "deliberate insults," "threats," "supplications," "appeals to sympathy," "wise-cracks," and the like represent *functional* classifications of verbal stimuli. Specifically, they represent some of the possible verbal techniques used by parents who wish to control their children, and by adults desirous of controlling the emotional and the overt behavior of other adults.

In Watson's illustration, the golfer told himself what to do on future occasions; he formulated verbal stimuli for the purpose of controlling his own responses. It is not uncommon, as a matter of fact, for a person to respond to his own verbal stimuli. He may laugh at his own jokes, appraise his own poetry, compliment himself verbally upon his good looks, or address disparaging epithets to himself. It is certainly possible for a person to carry on a prolonged conversation with himself. Thinking is thus a highly socialized process.

It is usually maintained that language, psychologically considered, comprises a system of substitute stimuli and substitute responses; this is in part correct, but it should be remembered that words are direct stimuli, capable of arousing all kinds of human (or animal) responses. Thus, while "wristwatch" symbolizes or represents an object, "liar" is calculated to elicit a direct response from the man who is so stigmatized. To state the situation differently, almost any response can become conditioned upon a verbal expression; and in point of

fact, the response in many instances is determined by and created by the verbalization itself.

That verbal conditioning is determined largely by social factors is quite evident. Of late, such expressions as "swell" and "lousy" have been adopted by the intelligentsia and by the "collegiate" type of university student. To illustrate further, the question of terminology is of major importance in discussions of sex behavior: words that relate to sex are dignified and refined or vulgar and disgusting, as the case may be, depending on the conditioned emotional responses which they arouse. Finally, we might note the extent to which affective reactions have become conditioned upon proper names. For reasons that we can rarely discover, we either like or dislike the names "Violet," "Mary," "Percival," "Algernon," etc. This also refers to pet- or slang-names, such as "Bozo," "Kid," "Baby," "Honey," and "Sugar."

Intelligence and Ability

As we have just seen, a human being is essentially an acting or a behaving creature who, even when he is thinking, is by no means physically passive. Both his thinking and the more overt forms of his behavior yield products which are capable of measurement and evaluation. Literary and artistic compositions and mechanical inventions are thus the products of human behavior. Creative behavior is also manifested by animals. The nest built by a bird is truly an accomplishment, the product of a certain form of behavior. Even the lowly ameba shows behavior which represents the accomplishment of some end. Behavior which results in *accomplishment* is known as ability.

In using terms to designate the various forms of ability, we must avoid the fallacies of the antiquated faculty psychology. Psychological functions are not faculties. Man does not remember his experiences by virtue of a faculty called "memory" nor does the bird build a nest because it possesses an "in-

stinct" for so doing. The act of remembering and the act of nest-building both involve the entire psychological equipment of the organisms concerned. Unfortunately, psychologists have tended to isolate one particular form or manifestation of ability, called "intelligence," and to regard it as an entity or a faculty. As a matter of fact, different aspects of the actual psychological phenomena ordinarily labeled "instinct" or "intelligence" have been discussed in all the chapters of this book.

Broadly speaking, all behavior is intelligent in so far as it results in successful adjustment to the environment. The white rat, in learning the shortest pathway to food in the maze, displays an activity which can be so designated. Moreover, of two rats confronted with the maze situation (other things being equal) the one that masters it in the shorter time and with fewer errors is the more intelligent. Likewise, the university student is intelligent to the extent that he adjusts himself to the social life of the campus as well as to his studies. The respective abilities manifested by the lawyer in conducting cases, by the physician in diagnosing and treating ailments, and by the business man in managing his affairs are all specific manifestations of intelligence. This usage of the term even includes skill in playing baseball and tennis, since aptitude in such activities literally includes adjustment to environmental stimuli. Indeed, such a conception does not appear extravagant when we reflect that the skill required in these and similar games is far beyond people of low-grade intelligence. Since the environment of higher organisms, man in particular, is social as well as physical, intelligence is shown in an extremely wide variety of responses. Without doubt, human intelligence is expressed in such traits as tact, emotional poise and control, the ability to understand human motives, motor dexterity, and facility in the use of language. From this standpoint intelligence and ability are synonymous terms.

The Concepts of Intelligence. Although the majority of psychologists accept in substance the view of intelligent be-

havior just indicated, a number of them restrict the term intelligence to mental activity which results in adaptive behavior. According to their position, intelligence is the cause and intelligent behavior is the effect. In reality, so they argue, the two factors are so distinguishable that the mental process may not result in overt behavior of any kind. Thinking does not always result in overt acting. One advocate of this view, Roback (27), goes so far as to state that "To see a problem sometimes denotes a higher degree of intelligence than to solve one." In general, this view holds that superior mental ability, and ultimately nothing else, differentiates human beings from animals, and intelligent men from morons and idiots.

Even psychologists who thus restrict intelligence to mental processes concede and frequently stress its function in making adjustments. For example, Angeli (3) defines reasoning as purposive thinking and as problem-solving imagination. Thinking with a purpose in mind means thinking directed toward the solution of some problem. It is regarded as good thinking to the extent that it is successful in solving the problem. Many insane patients *think,* sometimes with amazingly sound logic, and they are occasionally quite skillful in verbal arguments, but they are insane, nevertheless, because their thinking does not result in a successful adjustment to their environment. Of course in any act of thinking the problem concerned may be highly specialized, and only indirectly related to the biological or even the social welfare of the organism. No one questions the intelligence of Poe, notwithstanding his unpractical nature. But on the other hand, few people regard fruitless day-dreaming or fantasy building as manifestations of intelligence. Mental activities of this sort do not result in mental accomplishment. Intelligence is limited to demonstrations of real ability.

Definitions of Intelligence. There are evidently two ways of viewing intelligence: it is either (1) overt adaptive behavior, or (2) mental activity responsible for overt adaptive behavior.

The theoretical distinction between the two views of intelligence becomes fairly definite when we note how various psychologists define the term. Perhaps Stern's (30) definition is the best known of those which express the second view. According to this psychologist, "Intelligence is a general capacity of an individual consciously to adjust his thinking to new requirements. It is general mental adaptability to new problems and conditions of life." Other definitions are given in a symposium on the subject published in one of the psychological journals. In this symposium, Colvin (6) takes exception to Stern's definition on the ground that it is too narrow, and offers as a substitute the following: "An individual possesses intelligence in so far as he has learned, or can learn, to adjust himself to his environment." Colvin argues that his definition "does not unduly emphasize the problem aspect of intelligence and rightfully attributes intelligence to those animals whose sole ability to learn is confined to the hit-and-miss try-out of experience ('trial and error')." In a somewhat similar vein, Woodrow states that intelligence is an "acquiring-capacity," and Dearborn states that intelligence is "the capacity to learn or to profit by experience." He defines experience in terms of objective or behavioristic psychology. Thorndike defines intellect as the power of good responses from the point of view of truth or fact, but qualifies his definition by stating that "it is probably unwise to spend much time in attempts to separate off sharply certain qualities of man, as his intelligence from such emotional and vocational qualities as his interest in mental activity, carefulness, determination to respond effectively, persistence in his efforts to do so; or from his account of his efforts to do so, or from his moral or esthetic taste."

Several contributors to the symposium point out groups of factors which constitute intelligence. For instance, Freeman mentions such factors as mental balance, coördination of the mental processes, judicious management of the processes of learning or reflection, mental control, and a due degree of non-

suggestibility. Thurstone lists three components of intelligence: (1) the capacity to inhibit an instinctive adjustment, (2) the capacity to redefine the inhibited instinctive adjustment in the light of imaginally experienced trial and error, and (3) the volitional capacity to realize the modified instinctive adjustment into overt behavior to the advantage of the individual as a social animal. These are respectively the inhibiting, analytical, and persevering aspects of intelligence.

Among other views expressed in the symposium are two which limit intelligence strictly to conscious thinking. Thus Henmon accepts the definition that "intelligence is intellect *plus knowledge*," and Terman defends the view that "an individual is intelligent in proportion as he is able to carry on abstract thinking." Terman's view is, in fact, rather far removed from the broad concept of intelligence discussed above —that is, the conception that intelligence includes social traits and motor ability. To quote from his argument: "It cannot be disputed, however, that in the long run it is the races which excel in abstract thinking that eat while others starve, survive epidemics, conquer time and space, and substitute religion for magic, science for taboos and justice for revenge. The races which excel in conceptual thinking could, if they wished, quickly exterminate or enslave all the races notably their inferiors in this respect. Any given society is ruled, led, or at least molded by the five or ten per cent of its members whose behavior is governed by ideas." Terman is interested in excluding from intelligence all forms of adjustment that do not involve abstract analysis. He does not regard the skill required of street car motormen as a form of intelligence. However, his argument clearly points to successful adjustment and even dominance over others as the final criteria of intelligence.

It will be noticed that despite the variety of standpoints which they represent, these definitions of intelligence do not differ on questions of fact. For instance, considered as descriptions of actual psychological phenomena, the respective state-

ments of Colvin and Terman are in no respect contradictory. As our previous chapter disclosed, practically all organisms learn through experience. Moreover, men and animals in general employ the same learning methods. If the student were given 50 curves of animal learning and 50 of human, both obtained from a maze or a problem box experiment, he would experience considerable difficulty, in the absence of labels, in distinguishing between the two. On the other hand, no psychologists question the superiority of human over animal mental development and thinking capacity. The psychological gap between human and animal mental achievement is indeed large. Our sole question is whether intelligence should be applied to all cases of effective learning or restricted to those cases which clearly involve the higher mental processes.

As far as scientific psychology is concerned, the two opposed concepts of intelligence can be made equally serviceable. It should be repeated that they are based upon the same body of facts. To be more explicit, the student will find both concepts entirely in harmony with the facts and principles discussed in both the previous and present chapters of this text. *Intelligence* is primarily a popular term that has crept into psychological literature, and like other psychological terms of similar origin, it suffers from ambiguity. For this reason some psychologists prefer the less popular term, "mental alertness."

Innate *versus* Acquired Factors in Intelligence. The question of whether human behavior is determined primarily by heredity or environment has been argued countless times. Such arguments are fruitless because they are illogical. Their fallacy lies in their assumption that psychological functions can be classified as either wholly hereditary or completely environmental. The pupillary reflex is a function, involving not only a structural mechanism but a stimulus. The reflex mechanism is of course inherited, in the sense that the iris and its nerve connections are inherited, but it can function only with reference to environmental stimuli. Not only light but sound

stimuli elicit the pupillary response, and for all we know, one is as "natural" as the other. Conditioned pupillary responses very likely begin early in infancy. It is futile, therefore, to argue that pupillary responses are chiefly determined by either heredity or environment, for all of them are determined by both. We might as well argue whether the structure of an automobile or the skill of its driver is responsible for the fact that it can turn a corner. The principles of biological inheritance apply to structures, not to functions determined by those structures when placed in a stimulating environment.

It follows that receptors, effectors, and neural mechanisms rather than traits and abilities are directly heritable. Conversely, traits are heritable only in the sense that they are determined by inherited structures. As a matter of fact, few human traits appear in successive generations according to the Mendelian ratio. If intelligence, for instance, were a unit character, comparable with eye-color, it would either appear or not appear in a particular organism. Consequently, all people could be classified as "intelligent" or "not-intelligent," just as eyes are classified as brown or not-brown. But as L. S. Hollingworth (16) states, "All men can be no more divided into the dull and the bright, than they can be divided into the tall and the short." Human intelligence is found in varying amounts.

The assumption that intelligence is a heritable, Mendelian unit must not be confused with the supposition that the limits and direction of an individual's ability are fixed by his inherited mechanisms. In the opinion of some psychologists, the latter conclusion seems warranted by the available evidence. In Chapter I the dependence of activity upon morphological factors was stressed. In the sense of the principle there explained, prize-fighters are born and not made. The question is whether this can be said of poets, using poets, of course, to symbolize intellectual and artistic ability. It has been maintained that the *general level* of an individual's ability is estab-

lished by innate factors. Assuming this to be true, intelligence could be defined as potential native ability, whether restricted to mental processes or not. Two lines of evidence lend support to this conclusion. In the first place, the mental level of a given individual tends to remain fairly constant during any number of tests. His score in the first test is generally indicative of his scores in subsequent tests. In the second place, siblings (children born of the same parents) and twins (two children developed from the same ovum) respectively tend to show the same degree and quality of intellectual performance. This kind of evidence, however, is inconclusive because the environmental influences are exceedingly difficult to measure.

The Criteria of Intelligence. One source of confusion in discussions of intelligence emerges from the fact that the aspects of behavior to which it refers are measured by two different standards. Even when the term is limited strictly to mental processes, it sometimes refers to (1) the *difficulty* and *complexity* of a mental act, and sometimes to (2) the *social value* of the act. Thus, it is usually assumed that intelligence of a high order is required to solve difficult mathematical problems and to translate obscure Greek passages. The instructor frequently gauges the mental caliber of his students by the facility they disclose in wrestling with intellectual problems. He is flattered on being told that his course is exceedingly difficult, for he assumes that his standards are correspondingly high. Of course, it is not difficulty alone, but difficulty combined with complexity which constitutes this standard. People with prodigious memories are not necessarily regarded as intelligent.

On the other hand, mental acts characterized by both difficulty and complexity are not always regarded as intelligent. Many people admit grudgingly or flatly deny that excellence in playing bridge, solving cross-word puzzles, or anticipating the outcome of mystery stories is an indication of intelligence. When forced to defend their position, they fall back on the

argument that such accomplishments are less *worthy* than understanding Emerson or studying natural history. The perennial criticism directed against mental tests is that such tests place a premium on "mental gymnastics," and ignore profound thinking. Obviously the individual who belittles Phi Beta Kappa students places little *value* upon their intellectual attainments. He assumes and generally asserts that superior students do not possess the ability required in "practical" success.

At their best, standards for evaluating the products of intelligence and ability are shifting and uncertain. As Thorndike (32) has pointed out, geniuses are characterized by their rarity rather than their relative degree of attainment.[1] The recognition and financial compensation given to the best grand opera singer, as compared with the second best, are frequently disproportionate and unfair. Also, when a product ceases to be rare it is no longer hailed as a work of genius. The aviator who first looped the loop was truly a genius, but the numerous duplications of his feat have served to detract from his accomplishment. We tend to estimate intelligence from our own individual standpoint, hence we fail properly to evaluate anything beyond our capacities or interests. In such cases we tend toward the extremes of over-estimation or under-estimation. The savage is frequently at a loss to know whether the missionary should be eaten or deified. To give a more pertinent example, a vaudeville act of even mediocre quality demands of the performer an amount of skill and training not always appreciated by the audience. One inevitable result of an inability to appreciate intelligence is, of course, prejudice and dogmatism. As a consequence, we are likely to over-rate the intelligence of an individual who shares with us certain political or religious convictions, and to regard as stupid an individual with opposed views.

When we define intelligence from the standpoint of effective

[1] *Op. cit.*, p. 181.

adjustment, we are again confronted with the same two standards for its measurement. The problem for which the adjustment is made must present some real difficulty if its solution calls for intelligence. The act of swallowing involves a complicated physiological mechanism; if it had to be learned, it would doubtless be comparable in difficulty with playing a sonata on a piano. But since it is performed at birth with little or no practice it is not an act of intelligence. However, the sheer difficulty of an overt act is a poor indication of the intelligence which it requires. The individual who can hold himself motionless in some posture longer and better than any other individual in the world does not thereby display superior intelligence. At best he can hope only for the recognition accorded by circus or vaudeville patrons. As in the case of mental feats, the added factor of complexity fails to establish the act as intelligent. Many people use the term *skill,* rather than intelligence, with reference to the performances of the professional magician, boxer, typist, or pianist. Some even reluctantly employ "intelligence" to designate brilliant repartee or wit, preferring the term "cleverness."

To summarize, we find that irrespective of the way in which intelligence is defined, it is measured in terms of two standards which logically are distinct but practically are found together; namely, the standards of *difficulty* and of *value.* Furthermore, we have seen that in order to be regarded as intelligent, a difficult act must possess some degree of complexity. Since the standards are poorly defined, they are sources of confusion in both scientific and popular psychologizing.

We must conclude that intelligent behavior is the product of many factors, each requiring careful investigation for its analysis and definition. Thus the psychologist accepts the fact that social values fluctuate and proceeds to devise a technique for their measurement. At present, the values of human intelligence and ability can be studied most advantageously in

the realm of commerce and industry, where such traits are at a definite premium. Here the task of the psychologist, connected with a factory or department store, is to ascertain, measure, and evaluate in monetary terms the human traits of its actual or prospective employees. On the other hand, the nature of the factors constituting intelligent behavior, disregarding their social worth, are studied in the psychological laboratory. In the following section of this chapter we show how such studies are made.

Mental Measurements

Perhaps no phase of experimental psychology has attracted as much popular interest as the field of intelligence testing and measuring. But unfortunately, the assumptions underlying the technique of intelligence testing, and consequently the results obtained by this technique, have been generally misunderstood. It is one thing to administer and score tests, but it is another thing altogether to understand the psychological significance of test results.

The Nature of Psychological Tests. First of all should be noted the fundamental assumption underlying intelligence tests. As the name implies, they consist essentially of problems which presumably require intelligence for their solution. Since the purpose of such a test is to ascertain in short time certain facts about the intelligence of the individual tested, it necessarily consists of typical or *representative* problems. In other words, the test *samples* the intelligence of the person who takes it, in much the same way that a blood test made by a physician consists of an examination of a specimen of the blood of the patient. Obviously the intelligence test is valid only to the extent that its problems are truly representative.

Just what constitutes a representative test problem requires some explanation. In the light of our previous discussion it is evident that no test purports to measure directly the factor of sheer intellectual ability divorced from training and ex-

perience. This factor, or rather group of factors, is a logical and convenient abstraction, never found in isolation for the simple reason that mental *activity* cannot take place without mental content furnished by experience. Practically all tests of general mental ability include mathematical problems, verbal relationships, logical relationships, extent of vocabulary, various forms of reasoning, and general information.

The following test problems are fairly typical of those found in psychological tests for adults:

(1) Underline the word that does not belong with the other four words: light, candle, lamp, match, torch.

(2) The opposite of *minus* is (underline the correct word): times, add, substract, plus.

(3) The synonym, or word corresponding in meaning, for *haste* is (underline the correct word): energetic, quiet, rush, hasty.

(4) Write in the appropriate word: England: Europe = China: ——

(5) Correct this sentence: He is larger than any boy in his class.

(6) One of the three lists of words given below contains the words needed to complete the following sentence. Select the words in the correct list and write them in the blanks, one word to each blank: One ought to ——— great care to ——— the right ——— of ———, for one who ——— bad habits ——— it ——— to break them.

(a) Avoid, use, abundance, bad, morals, himself, assortment.

(b) Attach, indulges, awaken, visions, Heaven, learn, hard.

(c) Difficult, sort, contracts, cultivate, finds, habits, exercise.

(7) Write in the blanks two numbers that belong in this series of numbers: 5, 6, 8, 11, 15, 20, —, —

(8) Use the margin for figuring and write the answer in the space indicated: what is the average of 12, 29, 60? (Answer ——)

(9) Underline the nearest correct statement: Daniel Webster was a president of the United States—writer of a dictionary—United States Senator—governor of New York.

(10) Write in the parentheses the number of one of the 4 numbered statements that comes nearest expressing the thought of the quotation:

( ) "Do unto others as you would have them do unto you."——

1. It is easier to tell others what to do than to do it yourself.
2. Industry is its own reward.
3. Treat others as you want them to treat you.
4. Live and let live.

Although the effects of schooling, special training, and everyday experience cannot be eliminated from intelligence tests, they can be fairly well estimated in such a way that the final score made by the subject is a relative measure of his intellectual ability or mental alertness. One method of measuring such effects is to reduce them to a minimum. For instance, in one mental test problem the subject is asked to explain how two railroad trains going towards each other on a single track can be made to pass with the least amount of switching, when the only provision for switching is a single side-track shorter than either train. Since few of us are familiar technically with railroad switching, this problem is relatively fair for the majority of people. Another method of estimating training effects is to include training elements common to all people for whom the test is intended. Since they were selected from tests designed for college freshmen, the test problems quoted above were presumed to meet this requirement.

The Diagnostic Purpose of Tests. The purpose of a psychological test is to predict what the individual tested will do in some field of accomplishment. It measures what he has learned in order to predict what he is capable of learning. A test, therefore, is a psychological device used for mental diagnosis and prognosis. The psychological examinations frequently administered to college freshmen illustrate this purpose, since their aim is to predict scholastic success. Knowing the test score of a freshman, his dean is in a better position to know what sort of work he is *capable* of doing. Clearly the usefulness of tests designed for this purpose depends upon the degree of correspondence between the test scores and the school grades made by the students, and in order to make the scores and grades correspond as closely as possible, tests for college freshmen usually contain many items based upon high school training. Such tests fulfill their purpose with a fair degree of success because they show with what mathematical *probability* a given student will receive a given average grade.

Of course factors other than those measured by the tests help determine school grades: no one doubts that the habits of work, adaptation to particular courses and instructors, health, and traits of personality which characterize a student are instrumental in determining his scholastic success. But these facts in no sense militate against the scientific and practical value of the tests; if a student scores high in the test and is

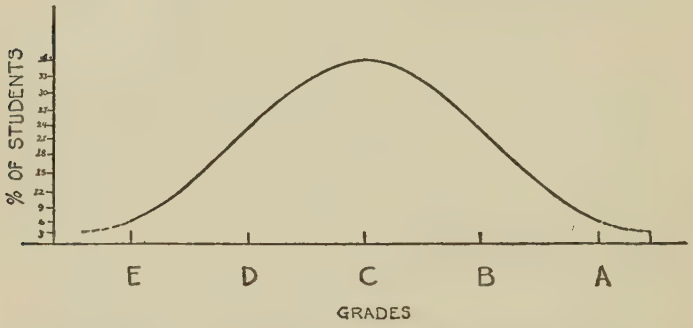

FIG. 29.—Curve of the normal distribution (approximate) of school grades described in the text. In curves of distribution the number of cases is indicated on the ordinate at the left, reading from bottom to top in the order of their increasing magnitude; and the measurements are indicated on the base line, reading from left to right in the order of their increasing value. (Those conversant with statistical methods will note that the extension of the curve represented by the dotted lines includes plus and minus 3 sigma.)

graded low in his work, the fact is significant; if the reverse obtains, the fact is equally significant. Far from arguing against the usefulness of the test, such discrepancies often throw considerable light on the intellectual and temperamental make-up of the people concerned.

Principles of Test Construction. It is indeed a mistake to suppose that psychological tests are merely thought out and then written. Tests must themselves be tested before they can be accepted as scientific. The most important principle of test construction is known as the *standardization* of a test.

In the majority of cases the test scores should show what is called a *normal distribution.* The term distribution refers to the proportion of scores of different values made by the subjects. It can be illustrated by the school grades commonly used, A, B, C, D, and E. A normal distribution of grades is represented by 7% of A's, 24% of B's, 38% of C's, 24% of D's, and 7% of E's. This distribution is expressed graphically

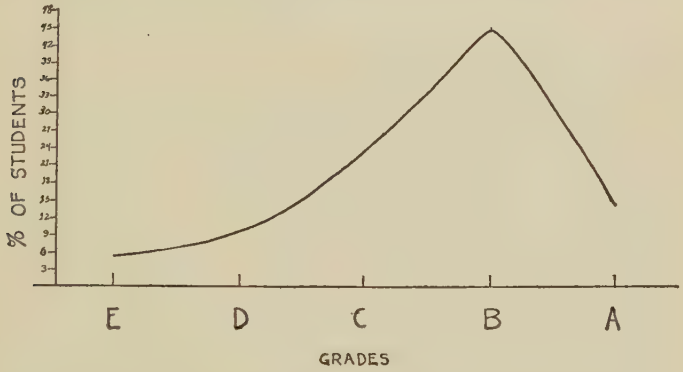

FIG. 30.—The skewed curve described in the text. This curve is skewed to the left, but skewness may be found in any part of a non-symmetrical curve.

by the *curve of normal distribution,* shown in Figure 29. This curve is symmetrical or bell-shaped, and its height bears a relatively fixed relationship to its width. The curve of a distribution which radically departs from the normal is non-symmetrical, or *skewed.* Figure 30 shows a marked skew, caused by the fact that the distribution which it represents consists of 15% A's, 45% B's, 25% C's, 10% D's, and 5% E's.

A normal distribution is so-called because it characterizes measurements of many natural phenomena. For example, the heights of adults belonging to a given race tend towards this distribution. In general, measurements of mental and physical human traits are normally distributed. It will be noticed that in the curve of normal distribution, the measurements are sym-

metrically grouped around a *central* tendency or average. Consequently, by means of such a curve it is possible to determine the significance of any given measurement.

Unless a test yields a normal distribution of scores, the chances are that it is either too difficult or too easy. One method employed to insure this result is to try out each test problem on a sufficiently large group of subjects. If 75% of the subjects answer a given test problem correctly, it is assumed to be of the right degree of difficulty. Sometimes a 50% basis is used.

A second principle is concerned with the *validity* of a test. By this is meant correlating or comparing a test with some other test or measure of the same ability. Assuming that grades in a course of instruction, say geometry, are measures of intelligence, a psychological test is valid to the extent that it correlates with these grades.

A third principle is the determination of the *reliability* of a test. Frequently many forms of the same test are devised; and the test is reliable if these forms correlate with each other. It should be emphasized that any test designed for general use must be standardized, validated, and made reliable in order to insure its diagnostic usefulness.

Administering and Scoring Tests. In giving psychological tests, the directions for examiners and subjects must be carefully formulated and followed. As a rule, both accuracy and speed are taken into consideration in administering and scoring an intelligence test. Sometimes tests are scored on the basis of the number of problems answered correctly, sometimes on the basis of the number of correct answers minus the number of wrong answers. Frequently one type of problem is considered superior to another, in which case it counts more in the total score than the other. The usual procedure in administering an adult test to a group is to limit the total time. Frequently the time for each individual subject is recorded and counted in the total score, and often a time limit is set for each group of problems in the test. In counting speed in

the final score, psychologists are merely following the practice which obtains in vocational life; *e.g.*, the bank teller must be both quick and accurate. Additional justification for this double standard is found in the fact that speed and accuracy vary together in the learning process.

Levels of Mental Ability. The method of constructing, administering, and scoring a test further depends in part upon the age of the person for whom the test is designed. It is generally stated that intelligence increases from birth to the period from 12 to 20 years, and then remains fairly constant until old age begins. Assuming this to be true, it is generally thought advisable to have different tests for the different age levels up to maturity. For example, tests for 3-year-old children include such items as pointing to parts of the body, naming familiar objects, repeating short sentences, enumerating objects in pictures. In the Stanford Revision of the Binet scale, made by Terman and his co-workers, problems for higher age levels include tests of vocabulary, the ability to repeat series of digits, understanding the meaning of prose passages, arithmetical reasoning, common information, and other items. Above the age levels of from 15 to 18 all tests are known as adult tests. The final rating on an age level test is usually the Intelligence Quotient, or I. Q., found by dividing the mental age by the chronological age. The mental age is the age level of the test which the subject can pass satisfactorily. According to many psychologists, the classification of individuals in terms of the range of their I. Q.'s is as follows:

Intelligence Quotients	*Classification*
0–69 [1]	Feeble-minded
70–79	Borderline
80–89	Backward
90–109	Normal
110–119	Bright
120–129	Very Bright
130 and above	Very Superior

[1] It is claimed by some that the feeble-minded group should be determined by the range 0–50.

Performance Tests. There are classes of people for whom tests involving the use of language are manifestly unfair. Illiterates constitute one of these classes, foreigners another. The intelligence of people thus handicapped can be measured by *performance tests,* which require them to do rather than to write or say something. To illustrate, they are given a *form board,* consisting of blocks of geometrical designs, such as stars, triangles, and squares, cut out from a board, and required to place the blocks in the appropriate holes cut in the board. They are given simple drawings or pictures with missing parts and asked to show what is wrong with the pictures. The picture may be of a table with one of the four legs missing. A more difficult kind of performance test consists of a series of related pictures which must be numbered in the order in which the picture should be arranged. In still another performance test, the subject attempts to draw the true path in the diagram of a maze by making a continuous line.

Tests of Physical and Motor Capacity. The principles which govern mental measurement apply in general to physical and motor testing. The latter technique involves the construction of appropriate pieces of apparatus. Anthropometric tests should be classified in this group, even though they include measurements of anatomical structures as well as physiological and psychological functions. They comprise measurements of chest capacity, handgrip, strength of back and legs, standing and sitting height, weight, body proportions, and the size and shape of the skull.

Tests of motor ability measure neuromuscular functions of varying complexity. Many of them are designed to measure the elements of coördinated responses enumerated in a previous chapter; namely, the direction, force, duration, and timing of muscular activities. Several *tapping* tests have been devised, to record the number of taps per unit of time an individual can make with a pencil or stylus held in his hand. The *tracing* test measures his ability to move a stylus along a

straight line. The *steadiness* test requires him to hold a stylus in holes of different diameters cut into a metal plate without touching the boundaries of the holes. In the *aiming* test he tries to strike the points of intersection of straight lines on a paper held at arm's length, making one attempt at each beat of a metronome. Muscular *strength* is recorded by the dynamometer, and muscular *fatigue* by the ergograph. Sometimes different elements of coördination are involved in a single test. For instance, in *card sorting* the subject sorts a shuffled deck of cards into appropriate boxes, labeled and placed before him, as rapidly and accurately as possible.

Tests of Special Aptitudes and Abilities. Very early in the history of intelligence testing, psychologists became interested in measuring special talents, capacities, and abilities; and to-day many tests of this sort are extensively and carefully standardized. Seashore's tests of musical talent and Stenquist's two tests of mechanical ability are excellent examples. We shall describe them in some detail for the purpose of noting the technique involved in their administration. The group of Seashore tests concerned with musical sensitivity is made with phonograph records, and it includes tests of sensitivity to pitch, intensity, time, consonance, tonal memory, and rhythm. The subject is seated before a phonograph with a pencil and a printed form upon which he writes his responses. When taking the sense of pitch test he hears pairs of notes, of varying degrees of pitch difference, sounded in close succession and separated by short intervals of silence, and after hearing the second note of each pair he writes either H or L in the appropriate place on the blank to indicate whether he hears it as higher or lower than the first note. This procedure is modified for the other tests to suit the kind of sensitivity which they measure, differences in rhythmic units, for example, being recorded as S for "same" or D for "different." In each of the records the test becomes more difficult as the record is played.

One form of the Stenquist test, known as the Stenquist Assembling Test, consists of a box containing a number of compartments, in each of which are the parts of some mechanical device. In one compartment is a toy pistol, in another a simple door lock, in another a spring mouse-trap, etc. The subject is given a small screw-driver and instructed to put each device together. The time spent in executing each task is recorded. The Stenquist Mechanical Aptitude Tests are issued in pamphlet form, and consist of pictures. The subject is asked to indicate by a letter system what parts of mechanical devices shown in the pictures belong together. Many other tests of special or vocational aptitude could be described, but the ones referred to illustrate the method of measurement upon which they are based.

It must not be inferred that these and similar tests measure all the abilities involved in the vocations or professions to which they belong. To illustrate, a consistently superior record in all the Seashore tests of musical sensitivity by no means marks the person who makes the record as a potential musical genius. Music is an exceedingly complex phenomenon, and the successful musician must possess a wide range of abilities, social as well as musical. Moreover, some musicians, the pianist for example, use a medium of expression which does not call for all the degrees of musical sensitivity measured in the tests. The pitches made on a piano differ by tones and semitones (a tone being the equivalent of 54 vibrations) whereas those made by the sense of pitch record vary from ½ to 30 vibrations. The Seashore tests should be regarded as diagnostic tests of certain specific abilities required in musical performance and appreciation; but these abilities do not constitute musical excellence.

Similar statements can be made regarding all tests of special aptitudes. Their usefulness lies in the fact that they measure the *essential* aptitudes involved in the vocations. Needless

to say, their significance is better understood when they are compared with other tests of a more general character.

Measurements of Social Intelligence. A high degree of intelligence is involved in making social adjustments. It assumes various forms, such as tact, a sense of humor, repartee, understanding the motives of people, and a more or less general ability to do and say the appropriate things with respect to others. To say that within certain limits these abilities can be cultivated in no sense differentiates them from other forms of intelligence.

Two sorts of technique are employed in the measurement of social intelligence; namely, (1) tests and (2) ratings. Such tests as can be classified under this heading in reality furnish measurements of social attitudes and practices. That is to say, they test social intelligence by measuring ethical standards, esthetic appreciation, opinions and prejudices, and the forms of emotional response most likely to be shown in social situations. Inasmuch as these are factors in *social adjustment,* they are properly regarded as manifestations of intelligence. The tests serve the purpose of establishing norms and of showing how a given individual stands with respect to the norms. Whether conformity or non-conformity to the norm is a sign of intelligence in any one test is, of course, a question of value which cannot be determined by the test itself.

The Moss Test of Social Intelligence is perhaps the most effective test yet devised for measuring some of the qualities involved in making social adjustments. As described by its author (20), the test consists of 6 parts, concerned respectively with judgments in social situations, the ability to recognize faces and to associate faces and proper names, the ability to interpret facial expressions, knowledge of human nature, knowledge of sports, current magazines, travel, music, etc., and the ability to detect the motives back of the spoken word. This has been applied to men and women, to persons of dif-

ferent ages, and to numerous social and vocational groups.

One method of testing the "sense of humor" will illustrate a technique for the study of similar social responses. The subject is given a pamphlet containing 10 samples of good, bad, and indifferent humor as determined, we shall say, by a group of "experts." He is then instructed to rank these samples in numbered order from "best" to "poorest." His rankings are then compared with the standard rankings or norms established by the expert judges, or possibly by the group taking the test. In this way it is possible to ascertain his "idiosyncrasy" score, or his deviation from the norm. If the experimenter in charge of the test wishes to compare reactions to humor with intelligence test scores or with scholastic ability, he can do so by employing the method of correlation, described below. Many other ways of treating the data could be devised.

The Pressey X-O test for the study of emotional responses follows a different method. In this test the subject is handed a pamphlet containing various groups of words with the instructions to cross out certain words in each group. In one, he is told to cross out all words the meanings of which are unpleasant; in another, he is to indicate by the same method things he has worried about; in a third group he crosses out a number of practices which to him are morally reprehensible; and he indicates words which in his mind are associated with other words. The Pressey X-O test does not purport to measure intelligence, but it is mentioned here for two reasons: it illustrates a psychological testing method, and it does measure certain emotional factors involved in social adjustment. Its results can be treated in the manner described above.

The rating scale provides for the systematic estimation of the traits of an individual by a group of competent judges or raters. The following hypothetical scale will show one way in which this is done.

GRAPHIC RATING REPORT

Instructions

Along the line opposite each quality, place a check at that point which, in your opinion, most accurately represents the student's degree of that quality. The adjectives below the line are merely suggestive; your check may be placed at any point which seems most accurately to represent your judgment. Please place each check directly on the line.

QUALITIES	REPORT				
I. Consider the student's *ability to learn;* the ease with which he grasps new ideas; his thinking ability. Base your estimate on his apparent capacity to learn, rather than on his perseverance and industry.	quick accurate thinker	alert, learns easily	fairly good understanding	slow to learn	dull
II. Consider his *willingness to work;* the readiness with which he goes about his work; his alacrity in undertaking new tasks. Is he energetic in his regular activities, or does he tend to "soldier" on the job?	unusually industrious	willing, steady worker	only moderately industrious	somewhat indolent, not active	sluggish, lazy
III. Consider his *ability* as *a leader;* the extent to which he influences and controls the activity of his associates. Consider especially his ability to induce men to work together effectively, and his success in dominating his group.	forceful, winning, "a born leader"	dominates and influences in most situations	about average in leadership	very little leadership	submissive, always a follower

In the type of rating scale illustrated above there is a description of each trait followed by a line representing successive increments of the trait. Just below each line are short descriptions of these increments, or differences in the amount of

the trait, so that the line itself is a scale. After studying the individual to be rated with reference to the traits described, each judge places a check mark at some place on the line to indicate his estimate of the amount of the trait possessed by the individual. The ratings are recorded independently and then compared. Usually the median or middle rating is accepted as the final rating of the subject.

The basic assumption underlying the rating scale methodology is that personality consists largely of the effects of impression produced by an individual upon others. For example, personal beauty is not an anatomical phenomenon, but rather the responses which the individual who "possesses" it elicits from others. The individual is beautiful in the sense that he arouses certain emotional and esthetic responses in others. This is shown by the fact that the standards of personal beauty vary from one time to another and from one race to another. That social intelligence likewise consists of effects or responses is apparent. Thus, the leadership of an individual is measured by the behavior responses of those whom he leads; an anecdote is humorous if it is so considered by competent judges.

Everything considered, the rating scale methodology is logically adapted for measuring many socialized phases of intelligence. It is commonly used in factories and in business and educational institutions where it is desirable to obtain estimates of achievement. It was used in the United States army during the recent war as one method for determining the efficiency of officers.

Mental Organization

We are now prepared to ask in some detail just *what* an intelligence test measures and samples. To say that it measures intelligence clearly begs the question, for this term is an abstraction which denotes an exceedingly wide range of responses.

A vocabulary test measures one kind of response, an arithmetical test another. We may surmise that the abilities which they measure respectively are related, but we can scarcely guess at the extent of the relationship. Still more problematical, in the absence of data, are the relationships which the various mechanical, mathematical, linguistic, literary, artistic, and social abilities bear among themselves and to each other. Whether an analogies test [1] measures general ability to see relationships or merely a specific ability to think of analogies has not yet been discussed. In order to ascertain what a given intelligence test problem measures, we must know how the ability which it samples is related to other abilities. This is the problem of mental organization.

The Method of Correlation. Relationships among abilities are studied by comparing measurements of these abilities. If algebra and geometry require the same kind of intelligence, people who excel in one should excel in the other, and those who are poor in the one should be correspondingly poor in the other. The nature of mental organization is studied by administering a variety of tests to groups of people and comparing the inter-relationships among the resulting scores. In making these comparisons, the scores from each test are compared with the scores of every other test.

The statistical method employed in comparing two series of scores is called *simple correlation.* It can best be explained by a hypothetical illustration. Let us suppose that 100 students who have completed a course in history have also been given an intelligence test. In order to correlate the two series of measurements, it is convenient but not necessary to arrange them in a *scatter-diagram.* The following scatter-diagram contains the results which we shall assume to obtain in our illustration:

[1] No. 4 in the list of test problems on page 284 is an analogies test.

INTELLIGENCE TEST SCORES

GRADES IN HISTORY	35–39	40–44	45–49	50–54	55–59	60–64	65–69	70–74	75–79	80–84	85–89	90–94	95–100	Totals
A								/	/	/	/	/		5
B				///	///	///	////	////	///	/	/	/		25
C		/	/	//	////	//// /	//// ///	//// /	////	////	//		/	40
D		/	//	/	///	////	//// //	///	///					25
E	/		/	/	/	/								5
Totals	1	2	4	7	11	15	20	15	11	7	4	2	1	100
	−6	−5	−4	−3	−2	−1	0	1	2	3	4	5	6	

In the diagram, each of the 100 students is represented by a mark so placed as to indicate both his history grade and his test score. The grades, ranging from A to E in descending order, are shown in the rows, while the scores are given in the columns. The scores have been divided into groups, each group including 5 points. The median grades, C, are in the row so designated; the median scores, 65-69, are in the column marked "O." As the table shows, one student, who scored from 90-94 in the test was graded B in the history course; 6 students with scores in the 70-74 group were graded C in the course; and 2 students with scores of 45-49 received D's in the course.

The table also shows the *distributions* of the scores and grades respectively. This term has already been defined. We note that both the scores and the grades approximate normal distributions. The mathematical formulæ ordinarily used to determine the amount of correlation presuppose normal distributions of measurements.

A scatter-diagram shows to some extent the *amount* of correlation represented by its two series of measurements. In our illustration, there is a fairly definite tendency for those

who excelled in history to score high in the test, and for those who fell down in history to score low in the test. This is manifested in the tendency of the marks to follow a diagonal line extending from the lower left-hand corner to the upper right-hand corner of the diagram.

The exact extent or amount of correlation between any two series of measurements is expressed by a number, usually a decimal fraction carried to two places, called a *coefficient of correlation.* This is computed by a formula. The coefficient representing perfect *positive correlation* is the whole number, 1.00. This coefficient would obtain if the individual with the highest score in one measurement would also have the highest score in the second measurement, if the next best person in the first measurement were also the next best in the second measurement, and if the remaining people down to the poorest showed similar parallel relationships in their scores of the two measurements. Below perfect positive correlation, the next highest coefficient is + .99, followed by + .98, + .97, and so on down to about + .20. *Negative correlation* is the inverse of positive. It results when high scores in one series of measurements accompany low scores in the second series. Its coefficients range from — 1.00, the coefficient of perfect negative correlation, to — .99, — .98, — .97, and so on to about — .20. Between approximately + .20 through zero to — .20 coefficients show a minimum, or *absence of, correlation.*

In psychological and educational investigations, tests are correlated with school grades, tests are correlated with each other, and school grades are correlated with each other. Perfect correlations, either positive or negative, are never found. As we explain subsequently, practically all coefficients are positive. According to Rugg (28), coefficients of less than .15 to .20 are negligible, indicating absence of correlation; coefficients from .35 or .40 show "present but low" relationship; coefficients from .35 or better to .50 or .60 show "marked" correlation; and coefficients above .60 or .70 indicate

"high" correlation.[1] Just what degree of correspondence a given coefficient represents, however, is to some extent a matter of arbitrary judgment and definition.

The coefficient of correlation between the history grades and the test scores of our scatter-diagram is + .402. Ordinarily this would be stated as + .40. In terms of Rugg's interpretation of coefficients, this indicates a marked degree of correlation. As a matter of fact, + .40 is about the average coefficient actually obtained in psychological and educational studies. There are several reasons why coefficients do not run higher, some of which have already been indicated.

The Significance of Coefficients of Correlation. Extreme caution must be exercised in basing conclusions upon coefficients. As several investigators have discovered, students coming from good homes do better school work than those coming from impoverished homes. Since it is reasonable to suppose that the better homes are equipped with telephones, a positive correlation would exist between the two factors, scholarship and possession of telephones. But no one would point to telephones as the *cause* of scholarship, any more than one would to automobiles. Possibly the better homes represent better American stock or superior social and educational advantages. A correlation of this sort indicates an incidental, or concomitant, rather than a casual relationship.

In the majority of instances, a positive coefficient indicates the presence of factors common to the two series of measurements correlated. When this is true, the relationship is causal in the sense that both measurements are due to common causes. According to Otis (22), the coefficient of correlation in such cases ". . . may be thought of as the decimal fraction which tells what proportion of the causes affecting the magnitudes of two variables are common to both variables." [2]

This definition may be illustrated hypothetically. A coeffi-

[1] *Op. cit.*, p. 256.
[2] *Op. cit.*, p. 185.

cient of + .60, we will suppose, is found between grades in government and grades in economics. This is obtained, of course, by correlating the grades in the two subjects obtained by the same group of students. We shall now assume that there are 10 factors of equal strength which determined each of the two sets of grades, but that 6 are common to both, while 4 are common to government alone and 4 others are common to economics alone. This makes a total of 14 factors. The following factors, we may imagine, are common to both studies: (1) emotional stability, (2) speed of writing, (3) background of training in social sciences, (4) extent of vocabulary, (5) health, (6) retentive memory. As factors which functioned only in determining the government grades we may list, (1) previous training in government, (2) practical experience in politics, (3) personality of the government instructor, (4) special interest in the government course. Although the same students took both courses, the four factors just enumerated were manifested only in the government class. Some of the students, for instance, had previously taken courses in government and some had not; but this factor, in itself, was as potent as any other factor in determining all of the government grades. In the same way, four other factors determined the economics grades, as follows: (1) business experience, (2) difficulty of the text-book, (3) training in a related subject, as history, (4) special interest in economics. Assuming, then, that all of the 14 factors were of equal strength, and that 6 of them were instrumental in determining both grades while 4 others helped determine the government grades and 4 additional ones determined the economics grades, the resulting coefficient would be + .60.

Partial Correlation. At times it is possible to ascertain the cause of a relationship between two abilities by correlating them together and by correlating each with a third ability. The method is known as *partial correlation,* so called because it partials out or eliminates the effect of the third ability upon

the other two. Our original illustration will serve to explain the procedure. It will be remembered that the coefficient of correlation between the history grades and the mental test scores was + .40. We shall now add a third measurement of ability obtained from the 100 students; namely, their grades in algebra. This gives us three abilities which we shall call "history," "algebra," and "mental ability." Using the method of simple correlation, we shall now correlate each of the three with the other two, obtaining the following hypothetical results:

(a) history correlated with (b) algebra = + .30
(b) history correlated with (c) mental ability = + .40
(c) algebra correlated with (c) mental ability = + .70

The three coefficients show that relationships exist between history and algebra, history and mental ability, and algebra and mental ability. It is possible, however, that the relationship between history and algebra is due to the third factor, mental ability. The method of partial correlation enables us to eliminate the effect of this third factor; and when it is used, the correlation between history and algebra is reduced to .03, indicating a negligible degree of relationship. Partial correlation, therefore, provides a method for measuring a factor common to three kinds of ability by eliminating the effect of one ability upon the other two.[1]

Theories of Mental Organization. As the result of studying coefficients of correlation among tests, particularly coefficients obtained by simple and partial correlation, psychologists have formulated three different views of the *nature* of intelligence. These are known respectively as the unimodal, the multimodal, and the non-modal theories. It should be explained that the term mode as used in statistics refers to the number or quantity most frequently repeated in a series of

[1] A third kind of correlation, known as *Multiple Correlation,* is omitted because it is relatively of minor importance in solving the psychological problem of mental organization.

numbers. To illustrate, C is the modal grade in the normal distribution of grades represented by 7 A's, 24 B's, 39 C's, 24 D's, and 7 E's, because it is the grade most frequently found. The term is used correctly in the names of the three theories, but in the interests of clarity it can be replaced by the word "kind." Thus the first theory implies that there is only one kind of intelligence, the second that there are several kinds, the third that intelligence cannot be classified into kinds or types.

(1) **The Unimodal Theory.** The first of the three theories assumes that there is only one kind of intelligence; namely, general intelligence or general ability. As the name of the theory suggests, this general ability is supposed to be distributed normally, thus yielding a curve showing only one mode. Since a given individual possesses a certain fixed amount of intelligence, he should do equally well in all forms of achievement. Theoretically, according to this conception, all coefficients of correlation among measurements of intelligence should be perfect and positive, for all individuals of a given mental level should do equally well in all mental performances. In thus stressing the unity of mental life, the unimodal theory conceives the brain to function as a unitary organ and not as a system of distinct organs each having a highly specialized function.

Advocates of this theory are forced to acknowledge the fact that individuals differ in their environment and training. The British psychologist, Spearman, has a modified unimodal theory to provide for such influences. According to his view, the score made by any given individual in any test is determined by two factors operating together; namely, (1) a *general factor,* conveniently called general ability, and (2) a *specific factor,* or the specific preparation which the individual has for the test. Thus, his ability in English composition is determined both by his general mental ability and his specific training in English composition. From the physiological standpoint

Spearman conceives the general factor as a common fund of neural energy aiding all mental activity, and the specific factor as a particular neural energy.

(2) **The Multimodal Theory.** The second theory assumes that there are *types* or kinds of intelligence. This distribution would obtain if tests of one type of ability should correlate more closely than tests of diversified abilities. Some advocates of this view describe such types as verbal or linguistic, mechanical, and social intelligence; others regard sensory discrimination, memory, imagination, and similar mental processes as kinds of intelligence. The student must not confuse names of tests with the assumptions of the multimodal view; for instance, it is one thing to label the Stenquist tests *Mechanical Aptitude Tests,* but it is another thing altogether to assume that they measure an actual type or kind of intelligence. As the term indicates, a multimodal distribution of intelligence is represented by a curve showing many (or several) modes.

Since many people tacitly accept some form of faculty psychology, we should expect the multimodal view to find frequent expression in popular psychologizing. Thus, the novelist is assumed to possess a highly developed faculty of "imagination," and the man endowed with "good judgment" is supposed to exercise this faculty, whether he is judging cattle or antique furniture. The majority of people and not a few psychologists seem to regard certain mental processes as general functions. "Concentration" is one of these implied general powers: it is a magic word used to explain why some students make good and others fail in their courses of instruction. Even after due allowance is made for transfer effects and identical elements, in forms of mental achievement, the belief in general powers or faculties is still discernible. Intelligence itself is frequently treated as if it were a unitary mental process or faculty.

(3) **The Non-Modal Theory.** According to the third view of mental organization, all acts of intelligence are specific, specialized, and independent, except in so far as they involve identical or common factors. If a test composed of arithmetical

problems correlates positively with one in the field of history, it is because both of them involve some such factor as ability to read, or perhaps ability to remember figures. Tests of social intelligence and of mechanical aptitude respectively could even correlate, for they might involve in common certain habits of muscular coördination. But aside from an acceptance of the identical factor principle, the non-modal theory stresses the mutual independence of all psychological activities, and criticizes any assumption of formal powers or faculties. It would find graphic expression in a curve showing no fixed modality.

The non-modal concept of intellect is not without its popular champions. Students are prone to emphasize the variability rather than the uniformity of their grades, and to explain any one grade in terms of the specific factors involved in its attainment. Popular views of vocational psychology assume that vocational aptitudes are independent abilities; the problem is to fit square pegs into square holes, round pegs into round holes, and to transfer maladapted pegs to appropriate openings. Only infrequently is it granted that a successful lawyer might have become an equally successful physician, or even business man.

Evidence Bearing upon the Theories. The available evidence concerned with the nature of mental organization discloses two sets of facts. In the first place, there is a marked general tendency towards *positive* correlation among test scores. And in the second place, certain groups of tests show higher inter-correlations than others. Both sets of results must be considered in an attempt to evaluate the three theories under consideration.

The two tendencies are summarized by Thorndike (33) as follows: "If we measure a group of men or children in respect to a random sampling of intellectual tasks, and score each on a scale running from low to high, or bad to good, using those terms in each case as psychologists or sensible persons in general would use them, we find two notable facts. All or nearly

all the inter-correlations are positive. The inter-correlations range from low to very high values." To quote another psychologist's (15) statement of the same principle, "All mental abilities are related," and "Negative coefficients of correlation have never been found, except occasionally by chance or selection."

Some examples will help explain the principles. In the article from which the above is taken, Thorndike gives his analysis of the American army mental tests. The inter-correlations among the groups of problems constituting these tests range from + .125 to + .746. Attention is called to the fact that these groups of problems are strikingly dissimilar: the standard form of the test, known as the Army Alpha, includes 8 elements—following directions, arithmetical problems, practical judgment, synonym-antonym, meaning of disarranged sentences, number series, analogies, and information. The Army Beta test, designed for illiterates, contains 7 elements.

Turning from tests to school courses of instruction, we also find positive inter-correlations. The following table of correlations among university grades, quoted from Hollingworth (15) and based on grades obtained from 50 students, may be taken as fairly typical of results obtained by other investigators:

	Psychol.	*Logic.*	*Hist.*	*Econ.*	*Eng.*	*Germ.*	*Chem.*	*Math.*	*Avge.*
Psychology		.60	.36	.52	.48	.49	.33	.54	.47
Logic	.60		.48	.57	.47	.41	.25	.57	.48
History ...	.36	.54		.44	.62	.46	.52	.61	.51
Economics .	.52	.57	.44		.51	.43	.45	.71	.52
English	.48	.47	.62	.51		.25	.26	.46	.44
German ...	.49	.41	.46	.43	.25		.39	.38	.40
Chemistry .	.33	.25	.52	.45	.26	.39		.57	.40
Mathematics	.54	.57	.61	.71	.46	.38	.57		.55

The mean coefficient is even higher than in mental tests.

In practically all fields of mental measurement, the principle is confirmed: positive coefficients of correlation obtain between intelligence tests and high school grades, intelligence tests and college grades, high school grades and college grades, intelligence tests and the Stenquist tests, intelligence tests and motor tests, intelligence tests and traits such as rapidity in mental accomplishment, tendency towards cheerfulness, desire to excel at performances in which the person is interested, self-confidence, degree of esthetic feeling, foresight, and between intelligence and money-earning capacity.

The Doctrine of Mental Faculties. The multimodal concept of mind is a modified form of faculty psychology, a doctrine based upon the erroneous assumptions of phrenology. In brief, faculty psychology holds that the mind consists of separate powers or faculties. One of its earliest forms divided the mind into the three faculties—intellect, feeling, and will, or as they were sometimes described, knowing, feeling, and doing. Subsequent varieties of faculty psychology included such powers of the mind as memory, imagination, reasoning, etc. This view of the mind assumes that imagination, for example, is an entity: a given individual possesses a fixed amount of imaginative ability, irrespective of the field of thought in which this ability is manifested. If he is imaginative in thinking about costume designing, he will be equally imaginative in thinking about machinery. In the extreme form of this doctrine, his imaginative power is assumed to be independent of his memorizing or reasoning powers.

Sufficient indication that the belief in mental faculties is popularly accepted to-day is found in such common expressions as the "power of observation," "power of concentration," "faculty of imagination," etc. It is also customary to speak of a normal man as being in "full possession of his faculties." According to phrenology, the various faculties are located in separate, circumscribed cortical areas. Some of the alleged faculties are amativeness, sublimity, veneration, and secretive-

ness. We might well add the mental faculties implied in the expressions just quoted. But no such cortical areas have been found: the brain does not function in the manner assumed by the phrenologists.

Our present criticism of faculty psychology is voiced from the standpoint of direct, psychological experimentation. Consider, for example, the alleged "power of observation." Even our unchecked, everyday experience points strongly to the conclusion that no such *general* power exists. On the contrary, it suggests that what one observes depends upon his individual interests, habits, and knowledge. The locomotive engineer habitually pays close attention to the different sounds emitted by his engine, but it does not follow that he is equally discerning while listening to a symphony orchestra. In general, an individual attends to what he is trained to notice. Experimental psychology strongly confirms this view. When a subject is permitted to see geometrical designs, words in various languages, and other graphic signs for a fraction of a second only, in an instrument called the *tachistoscope,* his ability to describe what he "sees" is found to be determined largely by his familiarity with it. A familiar English word is perceived in much less time than an unfamiliar foreign word. By a different experimental attack it has been shown that "imagination" is not a faculty or power, but rather a process of associating ideas furnished by experience. The chronic day-dreamer and the mechanical inventor are each imaginative, but in widely divergent ways. Instead of being actual traits of mind, the alleged mental faculties are exceedingly artificial abstractions, the products of a popular disposition to simplify unduly the facts of human nature. Applying the foregoing general conclusions to our present problem, we must conclude that intelligence does not consist of separate faculties. If it did, we could presumably devise tests for these faculties; but such tests do not exist. At best, a psychological test of "imagination" would merely measure the ability of an individual to imagine in terms

of geometry, clothes, machinery, finance, automobiles, gardening, and other unrelated fields of experience. Likewise, a psychological test of reasoning would necessarily include specific problems in different fields of reasoning. And there are obviously as many fields of reasoning as there are kinds of problems for human beings to solve. The extent to which an individual who excels in solving one group of problems will also excel in other groups is another question. Our present point is that reasoning, imagination, concentrating, observing, and the remaining so-called faculties are closely related aspects of specific acts of intelligence.

It should be said that a limited confirmation of the faculty theory is found in certain experimental results. The psychologist Woodrow (40) studied the phenomenon of attention under two conditions of complexity. In one of his experiments the subjects reacted to touch, sound, and light stimuli as quickly as possible; in the other, they fixated on a light, reacting with the right hand when it became brighter and with the left when it became dimmer. Woodrow concluded that a general capacity for attention exists, a "certain general ability to *attend* which remains the same, relative to other individuals' abilities, in spite of variations in the type of mental process concerned." Of course Woodrow would make full allowance for the rôle of experience as a determiner of attention, stressed above. His conclusion should not be identified with the original sweeping assumptions of phrenology and of the faculty concept.

Carey's (5) investigation of the mental processes of British school children led to more conservative conclusions. This psychologist failed to discover a function of "discrimination"; he ascertained the existence of a small, general memory factor, but he concluded that a general process like "painstaking" is much more limited than is usually assumed.

Motor Skill. It is possible that muscular coördinations constitute a group of abilities which are not only closely re-

lated but relatively independent of so-called mental abilities. Playing tennis and turning handsprings seem more closely related than either is related to solving algebraic equations. As we have explained, thinking is largely a muscular process, but it consists, nevertheless, of implicit muscular responses which differ considerably in character from the explicit responses involved in acts of skill. Our question, therefore, is whether motor abilities are more highly correlated among themselves than are motor and mental abilities.

Several investigators have studied motor skill in its relation to intelligence, using the motor tests described elsewhere in this chapter and correlating the results obtained with mental test scores. One of the earlier investigators, Wissler (39), found low correlations between simple motor and mental performances. Wooley and Fischer (41) tested 700 school children of Cincinnati, correlating measurements of memory and association with handgrip, steadiness, tapping, and card sorting. Their coefficients range from .15 to .21. Both Muscio (21) and Perrin (25) found that low positive coefficients obtain among motor tests. Other investigators have reported coefficients between motor and mental tests, and coefficients among motor tests, ranging from zero to .50 or better. These results are somewhat ambiguous, but on the other hand, Garfiel's (13) work points to a distinction between motor and mental abilities. She administered a series of motor tests to 50 girls, students in Barnard College, and secured ratings on their general motor ability. Her results include (a) intercorrelations among motor tests ranging from .15 to .25, (b) a high correlation, .77, between a team of motor tests and the combined ratings, and (c) a self-consistency of .92 among the judges. In other words, although her intercorrelations among individual motor test scores were no higher than those reported by other investigators, her composite score, based on several motor tests, agreed with the independent ratings furnished by judges. Garfiel concludes that the terms mental and motor refer to

different groups of abilities which tend to show a low positive correlation.

This conclusion, however, in no respect justifies the assumption of a general faculty of motor dexterity. It does not imply that general motor ability can be cultivated by practicing one motor coördination. It should be interpreted as meaning that different motor activities are based on overlapping factors, some of which, in all probability, are common to many of these abilities. Furthermore, many activities, such as playing bridge, obviously involve both mental and motor functions. In general, the nature of motor ability must be ascertained in the light of the entire evidence bearing upon mental organization.

Special Aptitudes and Talents. In all likelihood the so-called faculties are reducible to a few forms of mental ability which are more or less common to all mental activities. Retentive ability is perhaps one such form; ability to make sensory discriminations in a given sense field, another. Assuming this to be true, an individual's ability in a given direction is the product of all his so-called faculties, and not merely one of them. It is not so much a unit trait as the resultant of many traits.

This principle applies to the majority of special aptitudes and talents. For example, musical talent is based upon a number of contributing factors which exist in varying amounts and in varying combinations in different musicians. Seashore's inventory of musical talents includes five groups; namely, (1) musical sensitivity, (2) skill in musical execution, both vocal and instrumental, (3) musical memory and imagination, (4) musical thinking, and, (5) musical appreciation. Each of these in turn includes several subdivisions. Again, literary ability is not a unit trait, but rather a complex group of abilities. Furthermore, a given literary genius represents a group of highly specialized response systems peculiar to himself and collectively designated as his "style." Although Dickens and Thackeray were contemporary novelists, neither

could have written the novels of the other. The fact that special aptitudes vary with the individuals who disclose them indicates that they are largely products of individual experience and training.

On the other hand, the most essential ingredient of an aptitude may be at times a unit and perhaps a heritable factor. In the sense that they possess and possibly inherit the essential factors required in their accomplishments, poets, musicians, typists, mathematicians, prize-fighters, landscape gardeners, and various other specialists may be born and not made. But in most instances, the possession of the essential factor or factors is in itself no guarantee of successful accomplishment.

The nature and number of unit abilities which coöperate with other factors in determining vocational aptitudes have not been ascertained. Certainly a number of fundamental traits, such as intelligence, pleasing personality, and emotional poise, are important factors in many professions. Indeed, we may surmise that an individual's greatest vocational asset is his level of mental ability rather than some special talent. Scott (29) has pointed out the mistake of regarding vocational guidance as a method of placing square pegs in square holes and round pegs in round holes. As he explains, vocational adjustment is a dynamic process involving an inter-relationship between the factors of the individual and the factors of the vocational situation in which he is found.

The Complexity of Mental Organization. The considerations so far advanced lead to the general conclusion that all the elements of personality are involved in the organization of mental processes. Thus, intelligence cannot be divorced entirely from motor skill, and neither can be separated from its motivating factors. Bridge experts are expected to be interested in the game, whereas poor players may proclaim their lack of interest. But this fact does not explain whether interest is the cause and ability the effect, or vice versa.

Throughout the discussion we have stressed the necessity of

studying mental organization by experimental methods. A speculative approach to this problem is futile. Even though motives and abilities function together, it is possible to isolate them by the proper experimental technique. The British psychologist, Webb (38), investigated experimentally certain traits of character and intelligence in schoolboys, and concluded that he had isolated two variable factors; namely, "general ability" and "persistence of motive." His fellow-countryman, Garnett (14), discovered two factors which he called "cleverness" and "purpose." Now the existence of such traits as persistence, cleverness, and purpose is verified by everyday observations. Moreover, the technique of both Webb and Garnett is open to technical criticism. The point is that these investigators show the possibility of demonstrating and measuring character traits by purely quantitative methods. All traits of personality, including the traits designated as mental and motor abilities, are thus amenable to controlled investigation. Psychology has indeed progressed far beyond the stage where man's nature was supposed to consist of "knowing, feeling, and doing."

Personality

Our discussion of intelligent behavior has disclosed two significant facts: (1) An individual represents an *organization* of response tendencies. The entire organism and not merely one of its parts does the responding. It is therefore impossible to study a response without taking into consideration the entire reaction system of the organism concerned. Even a relatively simple human reaction, such as stooping to pick up a pin, involves to some extent all the factors which have been analyzed in the various chapters of this book. It involves a conditioning process, some motivating factor, and the principles of learning; and it may call for the functioning of language mechanisms.

(2) All responses represent attempted adjustments of the organism to the environment. In this sense, all behavior

culminates in what we have described as "intelligent behavior." An organism adjusts to the environment, however, by controlling or modifying the environment. As popular writers say, man "conquers" his environment. Intelligent behavior is thus a series of effects, and we measure intelligence by measuring its products. In social behavior, the *responses* of an individual are *stimuli* for other individuals. Such responses consist of gestures, facial expressions, speech, and movements calculated to produce effects upon physical objects. All of these, in turn, elicit responses from others.

Definitions of Personality. The two facts just stated have resulted in the formulation of two concepts of *personality:* (1) the individual considered as a behaving entity, and (2) the series of effects produced by a given individual upon others. Popular usage favors the latter view, as is witnessed by the expressions, "She has a pleasing personality," or "He is entirely lacking in personality." This view is also expressed in psychological literature, notably by Dunlap in the following statement: "The self of one individual, in so far as it is experienced by another individual, or in so far as it is estimated by another, is properly designated as *personality.*" [1]

Views which identify personality with the individual considered as a behaving entity fall into two classes: (a) One of these, to use Gordon Allport's (2) expression, includes all "rag-bag" theories of personality. Many writers stress the fact that all responses are organized into systems, but nevertheless define these systems from the standpoint of their constituent elements. Thus, according to Prince (26), "personality is a complex affair in that in its make-up there enter many factors, some acquired and some innate." These factors are "our reactions to the environment, our moral and social conduct, the affective reactions of our sentiments, instincts, feelings, and other conative tendencies, our 'habits,' judgments, points of view, and attitudes of mind." These, in turn, "are determined

[1] (10), p. 341.

by the mental experiences of the past by which they are developed, organized, and conserved in the unconscious."[1] To quote another writer, Warren (35) states that personality is "the total outcome of an individual's mental organization, comprising all his permanent mental conditions and organized experiences at any period of life."[2] Watson (36) holds a similar view, since he regards the individual's total repertoire of responses, active and potential, as his personality.[3]

(b) A number of psychologists find the explanation of personality in some basic principle which determines the behavior of the organism as a whole. Certain theories of motivation, discussed in Chapter IV, are really theories of personality. Psychoanalysts view the individual from the standpoint of the repressions, conflicts, sublimations, and other mental mechanisms which he represents. Psychoanalytical literature contains personality studies of Leonardo da Vinci (11), Darwin (17), Shelley (18), Charlotte Brontë (8), and other celebrities, along with similar studies of neurotic patients and normal men. Berman and some other writers, it will be remembered, explain personality in terms of endocrinal activities. Similarly, Kempf's view of autonomic functions is a theory of personality. Likewise, Cooley finds the origin and development of an individual's personality in the social groups with which he is identified. In views of this sort, personality is practically identified with character and temperament.

Human Traits. Personality studies are chiefly concerned with the analysis of *traits*. Three characteristics of traits should be noted: (1) The term refers to a stimulus-response *tendency*—that is, to some act of behavior which is manifested habitually and characteristically by a particular individual or by human beings in general. When we say that individual A is hypersensitive, witty, or skillful in dancing, we imply that he can be depended upon to show the trait in question more

[1] *Op. cit.*, p. 306 ff.
[2] *Op. cit.*, p. 409.
[3] *Op. cit.*, Chapter XI.

or less consistently. In fact, the aspect of personality known as *character* is usually defined in terms of the stability and dependability of response systems. If responses to stimuli did not tend to become habits we could not trust or distrust people, or select friends and associates. As a matter of fact, all organisms, even the most intelligent, are creatures of habit. We "know" or understand people to the extent that we can *predict* their behavior. Moreover, the fact that we do predict behavior within reasonable limits enables us to transact business, drive automobiles through crowded thoroughfares, and coöperate with others in various social, economic undertakings.

(2) A trait is a specific behavior tendency which must be defined in terms of a particular stimulus and a particular response. Any such general term as "strong-willed," "clever," "intellectual," "imaginative," "affectionate," or "narrow-minded," when applied to two people, or even to the same person on different occasions, is likely to designate two different traits. The fundamental error of faculty psychology is found, as we have seen, in its assumption that behavior can be analyzed in such general or abstract terms. To use a former illustration, an individual may be habitually neat with respect to his person, and characteristically slovenly in his handwriting or the care of his desk. The majority of traits are responses conditioned upon specific stimuli, and they are transferable to other stimuli only to the extent indicated in our preceding discussions of transfer and of mental organization.

(3) A trait must possess some social value. In other words, it must directly or indirectly attract *attention.* The normal pupillary reflex is not ordinarily regarded as a trait of human nature, but some peculiar habit of winking, on the other hand, is usually so designated. Although personal mannerisms, such as habits of walking, gesticulating, and eating may not tend to correlate closely with the more fundamental traits of human nature, they are nevertheless important elements in the composition of personality by virtue of the favorable or unfavor-

able attention that they attract. Obviously a trait that is highly desirable in one situation may be relatively worthless in another. Certain forms of mathematical ability which are indispensable in playing chess are quite superfluous in dancing. In stressing the values of traits in the composition of personality, we are merely applying one of the criteria of intelligence to all aspects of human nature.

Trait Measurement. Since traits are behavior tendencies, they are objective in character and therefore capable of measurement. Consider such diversified reaction tendencies as skill in serving a tennis ball, a tendency to blush, a fondness for ice-cream, a habit of flattering people, a proclivity for day-dreaming, and a knowledge of the French language. In accordance with the principle stated above, we must regard these as specific responses to specific stimuli; but we shall assume that they are found in many people. In the first place, if any one of these traits exists at all in a given individual, it exists in some appreciable amount. If 100 such individuals are selected at random, they can be ranged or ranked in the order of increasing or decreasing amounts of any trait chosen from the list. The first trait listed can be scored; the last can be tested; the others can be rated. In all probability, each of the hundred individuals would be found to possess either more or less of the trait than any other one individual; if perchance two or more should be scored, tested, or rated the same, their common rank could be ascertained by the proper statistical procedure. It follows, in the second place, that if a trait exists in some appreciable amount it can be measured. The unit of measurement which perhaps is most serviceable in personality analysis is the one suggested by our illustration; namely, the difference between a given rank and the rank just above or below it. Since this is the smallest difference actually *observed,* it is the smallest unit of difference to which a social value can be assigned. Thus, an instrument that would record exceedingly minute changes in the vasomotor reflex responsi-

ble for blushing would yield finer differences among people than are noted in social relationships. Like this hypothetical instrument, the majority of psychological tests yield finer measurements than are required for statistical or practical purposes. In general, traits are measurable because they are *observable* phenomena; and their quantitative gradations can be made as fine as scientific necessity demands.[1]

Traits are isolated and described by two different methods. The first is analogous to the procedure of the naturalist, who studies animals in their native habitats. The psychologist may wish to study human nature where it is normally disclosed—on the street, in the theater, in business institutions, and in the home. In situations of this sort, he notices some trait and proceeds to study it systematically. The rating scale or some similar device is admirably suited for this purpose. And just as the naturalist occasionally captures a specimen and brings it into his laboratory, so the psychologist may become interested in an individual and ask him to report to the psychological laboratory. But unlike the animal, the human subject, particularly the adult, is frequently quite willing to be analyzed. Often a trait is first observed in daily life and then subjected to laboratory investigation. For instance, Moore and Gilliland (19) investigated experimentally the tendency of certain people to look others straight in the eye while talking to them. In many instances, the Landis investigation for example,[2] the psychologist can duplicate in his laboratory the stimulating conditions which are found in social and economic activities.

The second method is similar to that of the experimental biologist. It consists of arranging a stimulus situation in the laboratory and analyzing the response which it elicits. In this case the response may be exclusively a laboratory product,

[1] See Thorndike (31) for a discussion of the principles stated in this paragraph.

[2] See Chapter IV.

selected because of its promise to reveal some significant trait manifested in normal activity. The Downey Will-Temperament test illustrates this method. This test measures certain volitional capacities of an individual by requiring him, among other things, to write phrases and to trace simple outlines on paper under varying conditions of speed, accuracy, distraction, and hindrance. Of course the significance of such tests must be established in terms of their correlations with other tests and with ratings.

The Doctrine of Mental Types. Popular systems of personality analysis frequently proceed upon the assumption that people either possess or do not possess certain traits. According to this assumption, people can be classified into *types* depending upon whether or not they have the traits in question. Because they are objective and tangible, physical characteristics most commonly form the basis of type differentiations. We are familiar with the alleged blond and brunette types, and the coarse and refined types. A less known classification, based upon the face profile, describes the convex, concave, and plane type of human individuals. Of course such physical characteristics exist; our question concerns the assumption that they are correlated with distinctive mental and temperamental response tendencies. If current beliefs are to be trusted, individuals with red hair have quick tempers, brunettes are highly emotional, and people with convex faces possess an abundance of mental and physical energy. Statements of this sort are to be found in widely advertised systems of "character analysis."

Other theories proceed to describe mental types with no attempt to correlate them with physical signs. Such theories, stated in the most extreme form, are unfortunately found in psychological literature. The traditional sanguine, phlegmatic, choleric, and melancholic temperaments will be recalled. A recent theory, mentioned in our discussion of motivation, describes temperaments in terms of predominating endocrine

functions and thus classifies people into the thyroid, adrenal, pituitary, and thymus types, with provisions for mixed glandular types. We have also mentioned the psychoanalytical distinction between introverts and extroverts. Many type classifications are restricted to mental processes. An example is found in the attempt of the earlier psychologists to describe visual, auditory, motile, tactile, and verbal types of mental imagery. People have been classified with respect to their method of making decisions into quick constant, slow constant, quick inconstant, and slow inconstant types. A favorite type of classification distinguishes between rapid learning and rapid forgetting as opposed to slow learning and slow forgetting. In fact, so many assumed psychological types exist that their mere enumeration would occupy several pages of this book.

Criticisms of Type Psychology. One fundamental criticism applies to practically all theories of mental types: they cannot be reconciled with the principles governing the distribution of trait measurements. It will be remembered that measurements of traits tend to show normal distribution; that is, they tend to cluster around a central tendency or average. The majority of men are of average height; fewer men are either tall or short; and an extremely limited number are giants and dwarfs. We have already quoted L. S. Hollingworth's statement to the effect that men in general cannot be classified as "tall" or "short." Yet this sort of classification is assumed in the majority of type theories. Although such traits as introversion and extroversion, for example, can be found, we have every reason for believing that *typical* introverts and extroverts, like typical tall men and short men, are comparatively rare. On the contrary, the majority of men in all probability are mid-way between the two extremes. The so-called types, therefore, are extremes which are rarely found and consequently not typical. Just as theories which describe two opposed types assume a bimodal distribution of traits, theories of three or more types presuppose multimodal distri-

butions. In his investigation of the socially and the mechanically inclined people, Max Freyd (12) expresses this criticism and states that his trait measurements tend towards normal distributions. Few psychologists, in fact, have ever reported bimodal distributions of human traits. Thorndike summarizes the doctrine of type psychology by saying that variations in measurements of a single trait center around one type only; namely, the average or mediocre type.

Classifications of types based upon physical characteristics are open to additional criticisms. They are theoretically unsound, and they lack experimental confirmation. Most of them are products of reasoning by analogy. Thus, fine texture of hair and skin is supposed to indicate refinement of temperament; and conversely, coarse hair is alleged to show a coarse, brutal nature. At least one theory of this sort has been tried in the psychological laboratory and found wanting. Paterson and Ludgate (23) secured ratings from 94 judges on 26 assumed traits of blonds and brunettes. Each judge was asked to select and rate 2 blonds and 2 brunettes with respect to the traits. Notwithstanding the fact that 187 blonds and 187 brunettes were rated, no correlations were found between their traits and their color: both blonds and brunettes respectively were found to possess an equal number of blond and brunette traits. In general, the claims made by professional phrenologists, physiognomists, and graphologists find little support in facts. Very often, it is true, the health, occupation, and social status of an individual are reflected in his personal appearance and behavior, particularly in his conversation, but this is far from saying that such characteristics represent psychological types.

Types Established by Group Activities. In two essential respects, however, types may be said to exist. People who belong to a given profession, social level, geographical section, nation, or race undoubtedly show certain distinctive characteristics. Business men develop habits of acting, talking, and

thinking which differentiate them from artists. Likewise, residents of different parts of the country acquire distinctive accents and mannerisms. In a sense, therefore, we may speak of the typical business man, university professor, actor, politician, Englishman, Frenchman, or perhaps boy or girl. But the differences represented by such types are superficial rather than fundamental. For example, no significant mental differences between the sexes have been established. As Thorndike expresses it, men differ more among themselves than men differ from women; and conversely, women differ more among themselves than women differ from men. In all probability this statement could be paraphrased to include the majority of mental and temperamental differences among races of the same intellectual level. We also have reasons for believing that distributions of human traits are much the same in all localities. Measurements of intelligence obtained from students in different universities are strikingly similar: they show the same range of scores from low to high, and they are distributed normally. According to Brogan's (4) results, students from universities located in widely separated parts of the country have practically the same ethical standards. In fact, there are mental types only in the sense that there are levels of intelligence. Undoubtedly, as the Army Alpha mental tests indicate, professional men are more intelligent than day laborers and white men are generally more intelligent than Negroes. Aside from differences in mental ability, the so-called mental types chiefly represent variations in custom and tradition.

The following quotation illustrates concretely the conclusions just formulated:

> If you were to draw up a list of a thousand human traits, Englishmen and Frenchmen would be bound to have 999 of these traits in common. The 1 per cent of difference would be found to consist in the fact that the Englishman says "Yes" and the Frenchman says "Oui, oui"; the Englishman prefers beef from the joint and the Frenchman likes his meat en casserole; the Englishman likes to go out into the fields and

shoot something and the Frenchman prefers to sit around a table and talk. And yet that 1 per cent margin is the thing that makes words like "Englishman," "Frenchman" or "American" carry a thrill like very few other words in human speech.[1]

Types Established by Single Traits or Characteristics. Very often the presence of a given trait or characteristic *in any noticeable quantity* suffices for purposes of type classification. In this sense there are "types" of insanity, physical disease, temperament, physical beauty or ugliness, mental ability, goodness, and the like. And in this sense it is possible to describe the type, "red-haired people," provided that no sweeping implications are made regarding other traits in the people so classified. It is likewise possible to describe the "mathematical" type of mind in referring to people who show mathematical aptitudes. But again we should be cautious in assuming a correlation between this trait and any other given trait. The fact that individual *A* is a mathematician in itself tells us nothing concerning his moral character, musical ability, political views, sense of humor, skill as a tennis player, or physical beauty. In the majority of instances type classifications based upon the possession of single traits are relatively useless. The majority of human traits, in fact, are possessed by all people. Only when the relative amount of the trait is known or inferred is the classification of practical or scientific value.

The Elements of Personality. Although any classification of human traits is entirely arbitrary, it is possible to describe three groups of traits which, taken by and large, include the most significant elements in personality. According to our classification the outstanding aspects of a human personality are his (1) physical characteristics, (2) temperament and character, (3) intelligence and ability. The traits included under these headings are primarily effects or impressions pro-

[1] From an article by Simeon Strunsky in the *New York Times Book Review*, July 20, 1924.

duced by a human being upon his fellows. Technically speaking, they are stimuli to which his fellows react. As our brief discussion will show, the last group is the most inclusive of the three.

(1) The physical characteristics of an individual are sources of a large number of the effects produced by that individual upon others.[1] People are attracted by a pretty face and a well-proportioned body, by pleasing manners, by a well-modulated voice, by signs of personal cleanliness; conversely, they are repulsed by ugliness and deformity, by atrocious manners, and by indications of personal uncleanliness. The advertising pages of magazines testify to the popular demand for stylish clothing, personal ornaments, cosmetics, fat reducers, and hair restorers. In daily conversation people give due consideration to the physical characteristics of their associates. Notwithstanding the traditional assurance that "beauty is only skin deep," the majority of people are probably influenced by such factors to a greater extent than they realize.

Physical appeal is frequently responsible for reactions which are highly rationalized. The physical is easily confused with the mental and moral. In myth and fairy story, in the popular novel and in the moving picture, virtue is closely associated with beauty, and vice is identified with ugliness. Cinderella is both good and beautiful; Uriah Heep is morally and physically obnoxious. Of course beauty of person may be a relatively subordinate factor in physical appeal. As far as intelligent adults are concerned, people are attracted or repulsed primarily by personal habits and mannerisms and by such forms of expressive behavior as facial expressions, gestures, bodily postures, and vocal inflections. It is with reference to forms of expressive behavior that physical attractiveness and repulsiveness become confused with temperament and intelligence.

[1] For a more extensive discussion of physical attractiveness and repulsiveness see Perrin (24) and Dunlap (9).

To a certain extent the physical appeal of an individual is indirectly responsible for his character and temperament. Other factors being equal, physically prepossessing people are more likely to elicit favorable responses from others. Children who are unduly petted tend to become "spoiled." Since physically attractive adults are socially in demand, they presumably tend to be socially active and, as a consequence, they acquire certain traits of character not found in those who lead secluded lives.

The relationships between physical appeal and intelligence have not been fully ascertained. In the investigation mentioned (24), a coefficient of + .02 was obtained between ratings on physical attractiveness and mental test scores, a result which argues against the traditional antithesis between "beauty and brains." On *a priori* grounds, we could expect to find either a positive or a negative correlation. For the reasons advanced above, physically attractive people might be supposed to excel in social intelligence. Moreover, physical attractiveness presupposes a certain amount of good health, an asset which is surely not incompatible with mental vigor. On the other hand, attractive people, by virtue of their social qualifications, may be tempted in the direction of intellectual laziness. Probably the coefficient obtained represents a balance among factors operating to a slight extent in both directions.

(2) The traits of temperament and character consist of the *attitudes* which people manifest in response to social situations. The term refers to an immediate, more or less unanalyzed reaction, containing both emotional and ideational elements. The majority of opinions, prejudices, ideals, sympathies, antipathies, personal likes and dislikes, esthetic and ethical responses, and sentiments are attitudes. An illustration of a relatively simple attitude is found in the crouching position of a cat, watching a mouse hole and ready to spring upon its

intended victim. In this instance, the attitude is a motor set and its accompanying state of visceral tension; functionally it is a condition of preparation for overt action. A complex human attitude is illustrated by the individual with some pronounced and fixed political bias. Psychologically the two cases have much in common. In both, the attitude is a *reaction tendency* which involves practically the entire physiological equipment of the organism concerned.

Individual differences in character and temperament are represented by differences in attitudes. Professional criminals, for instance, vary greatly among themselves in intelligence and education; they differ from law-abiding citizens chiefly with respect to the attitude which they take towards society. The same can be said of people noted for their strong esthetic or moral reactions. In both fiction and biography, character analysis takes the form of analyzing personal and social attitudes.

(3) We have already stressed the fact that all human traits are valued ultimately in terms of their effectiveness in adjusting individuals to their environment. For this reason, intelligent behavior has been viewed in this text as the highest form of behavior. To the extent that an individual utilizes successfully all of his response systems for the purpose of achieving social and vocational ends, he is intelligent. From this point of view, such a trait as tact, no less than proficiency in some mental performance, is a manifestation of intelligence. To illustrate further, an "ideal" is essentially a *plan of action,* formulated verbally and valued as "high" or "low" in terms of human welfare. It is indeed significant that the terms used to describe the different kinds of personality all reflect the standard of adjustment. The personality of an individual is "strong," "compelling," "magnetic," "pleasing," or "forceful" if his social adjustments are successful; otherwise it is "weak," and in extreme cases he is "utterly lacking in personality."

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